PHYSICAL
SCI. LIB.

QE
89
A1
C32
NO. 45

# MEETING THE EARTHQUAKE CHALLENGE

Final Report to the Legislature
State of California
by the Joint Committee
on Seismic Safety

*mitted Pursuant*
*he Provisions of Senate*
*current Resolution 128 (1969)*
*uary 1974*

UNIVERSITY OF CALIF
DAVIS
MAY - 1 1974
GOVT. PUBS. - LIBRARY
U.C.D. LIBRARY

U.C.D. LIBRARY

# MEETING THE EARTHQUAKE CHALLENGE

Final Report to the Legislature
State of California
by the Joint Committee
on Seismic Safety

*Submitted Pursuant*
*to the Provisions of Senate*
*Concurrent Resolution 128 (1969)*
*January 1974*

U.C.D. LIBRARY

## MEMBERS OF THE JOINT COMMITTEE ON SEISMIC SAFETY

Senator Alfred E. Alquist, *Chairman*
Assemblyman Jim Keysor, *Vice Chairman*
Senator Joseph M. Kennick
Senator Alfred H. Song
Senator James E. Whetmore
Assemblyman Leroy F. Greene
Assemblyman Richard D. Hayden
Assemblyman Paul Priolo

## CHAIRMAN OF THE ADVISORY GROUPS

Karl V. Steinbrugge

## ADVISORY GROUPS

Advisory Group on Engineering Considerations and Earthquake Sciences
Gordon B. Oakeshott, Chairman

Advisory Group on Disaster Preparedness
Robert A. Olson, Chairman

Advisory Group on Postearthquake Recovery and Redevelopment
Will H. Perry, Jr., Chairman

Advisory Group on Land Use Planning
George G. Mader, Chairman

Advisory Group on Governmental Organization and Performance
Marcella Jacobson, Chairman

SEMBLYMAN JIM KEYSOR
VICE CHAIRMAN
IATOR JOSEPH M. KENNICK
IATOR ALFRED H. SONG
IATOR JAMES E. WHETMORE
EMBLYMAN LEROY F. GREENE
EMBLYMAN RICHARD D. HAYDEN
EMBLYMAN PAUL PRIOLO

ROOM 5031
STATE CAPITOL
SACRAMENTO 95814
(916) 445-9740

# California Legislature

## Joint Committee on Seismic Safety

SENATOR ALFRED E. ALQUIST
CHAIRMAN

January 9, 1974

Honorable Legislators and
Citizens of California
State Capitol
Sacramento, California 95814

Dear Colleagues and Californians:

The Joint Committee on Seismic Safety, established in 1969 by Senate Concurrent Resolution 128, is pleased to present its final report. This document is the result of four years of intensive study by Committee members and over 70 technical advisors. These volunteer advisors have donated tens of thousands of hours of their time and deserve the heartfelt thanks of all Californians.

Our recommendations are presented in two sections: first, a comprehensive approach to seismic safety including high-priority legislative proposals, and second, five detailed advisory group reports. These recommendations are supported by a third section of supplementary materials.

As a result of advances in technology, as well as the tragic experience of the 1971 San Fernando earthquake, we now have the knowledge necessary to substantially reduce earthquake risks. Certain seismic safety measures have already been implemented by legislation sponsored by the Joint Committee, but much remains to be done. Meanwhile, the potential for earthquake catastrophe continues to increase as population concentrates in urban centers and hazardous buildings remain in use.

The key question faced by the Committee during its study was to determine acceptable levels of earthquake risk for Californians. How much loss of life and property damage are we willing to risk in future tremors? What costs are we willing to bear to reduce those risks?

In this report we present what we consider to be prudent precautions, those essential, yet economically realistic steps that can and should be taken to prepare for future earthquakes. We encourage your thorough study of this report and welcome your comments.

Very cordially,

Alfred E. Alquist, Chairman
Joint Committee on Seismic Safety

AEA:mc

# Contents


LETTER OF TRANSMITTAL . . . . . iii

**PART ONE: A COMPREHENSIVE APPROACH TO SEISMIC SAFETY** . . . 1

Preface . . . . . 3
An Overview: Putting It All Together . . . . . 5
The Principal Earthquake Hazard: Works of Man . . . . . 5
Guidelines for Seismic Safety . . . . . 5
Performance: Past and Present . . . . . 6
A Systematic and Responsible Approach . . . . . 7
The Proposed Program . . . . . 8
A Basic Legislative Package . . . . . 11
California Commission on Seismic Safety . . . . . 11
Land Use Planning Measures . . . . . 12
Building Construction . . . . . 15
Abatement of Hazardous Buildings . . . . . 18
Critical and High-Exposure Facilities . . . . . 20
Emergency Preparedness Measures . . . . . 22
Research . . . . . 24
An Additional Agenda of Critical Recommendations . . . . . 27
Further Employment of Land Use Controls . . . . . 27
Additional Design Measures for Seismic Safety . . . . . 27
Furthering Preparedness, Response, and Recovery . . . . . 28
Training and Education . . . . . 28
Earthquake Insurance . . . . . 29
Governmental Roles in Seismic Safety . . . . . 30
The State Government . . . . . 30
Local Government . . . . . 31
Regional Bodies . . . . . 31
The Federal Government . . . . . 32

**PART TWO: ADVISORY GROUP REPORTS** . . . . . 33

Introduction . . . . . 35
History and Authority . . . . . 35
Organization . . . . . 36
Major Accomplishments . . . . . 37

*Report of the Advisory Group on Engineering Considerations and Earthquake Sciences* . . . . . 45
Advisory Group Membership . . . . . 46
Introduction: State Policy . . . . . 47
Summary of Recommendations . . . . . 48
State Earthquake Commission . . . . . 49
Structural Standards and Codes . . . . . 49
Revision of Existing Requirements . . . . . 49
Training of Building Officials . . . . . 50
Safety of Dams . . . . . 51
Hazardous Structures . . . . . 51
Development and Environmental Impact . . . . . 52
Lifeline Services . . . . . 52
Insurance and Land-Title Problems . . . . . 52

Information and Education . . . . . 53
Disaster Plans and Operations . . . . . 53
Research . . . . . 54
*Report of the Advisory Group on Disaster Preparedness* . . . . . 57
Advisory Group Membership . . . . . 58
Introduction . . . . . 59
Scope and Purpose . . . . . 59
Definitions . . . . . 59
The Preparedness and Response Environment . . . . . 60
Assignment of Priorities . . . . . 62
Implementing the Recommendations . . . . . 62
Disaster Planning . . . . . 64
Authorities and Policies . . . . . 64
Jurisdictional Roles in Disaster Planning . . . . . 66
Special Planning Considerations . . . . . 69
Strengthening Operating Capabilities . . . . . 77
Structures, Supplies, and Equipment . . . . . 77
Training, Eduction, and Information . . . . . 79
Financial and Administrative Measures . . . . . 81
Evaluating Performance . . . . . 86
Minimizing Future Disaster Problems . . . . . 90
*Report of the Advisory Group on Postearthquake Recovery and Redevelopment* . . . . . 97
Advisory Group Membership . . . . . 98
Introduction . . . . . 99
Postearthquake Financial Assistance . . . . . 101
Insurance . . . . . 101
Loans . . . . . 103
Grants . . . . . 105
Priorities . . . . . 106
Recommendations . . . . . 107
Immediate Postearthquake Procedures . . . . . 107
Long-Term Postearthquake Actions . . . . . 110
Postearthquake Utilization and Compensation of Professionals . . . . . 112
Pre-earthquake Hazard Reduction . . . . . 113
Supplementary Information . . . . . 120
*Report of the Advisory Group on Land Use Planning* . . . . . 121
Advisory Group Membership . . . . . 122
Introduction . . . . . 123
Land Use Planning . . . . . 125
Background . . . . . 125
Recommendations . . . . . 127
Zoning Regulations . . . . . 134
Background . . . . . 134
Recommendations . . . . . 134
Subdivision Regulations . . . . . 135
Background . . . . . 135
Recommendations . . . . . 135

Building, Grading, and the Sale of Property . . . . . 139
Background . . . . . 139
Recommendations . . . . . 139
Geotechnical Assistance for Local Governments . . . . . 141
Background . . . . . 141
Recommendations . . . . . 141
Additional Measures . . . . . 144
Background . . . . . 144
Recommendations . . . . . 144
Supplement on Fault Hazard Control . . . . . 146
Recommendations . . . . . 146
Discussion . . . . . 147

*Report of the Advisory Group on Governmental Organization and Performance* . . . . . 151
Advisory Group Membership . . . . . 152
Introduction . . . . . 153
Summary of Recommendations . . . . . 154
Governmental Organization for Seismic Safety . . . . . 156
The Basic Role of Government at Each Level . . . . . 156
A Cooperative Program for Seismic Safety . . . . . 157
Land Use Planning Policies . . . . . 160
The Problem in California . . . . . 160
Approaches to the Problem . . . . . 160
Structural Safety . . . . . 164
Engineering Standards for New Construction . . . . . 164
Enforcement of Standards . . . . . 165
Abatement of Hazardous Structures: A Two-Phase Program . . . . . 165
Information and Education . . . . . 168
Promoting Public Support for Seismic Safety . . . . . 168
Information to Guide Individual Behavior . . . . . 168
Information for People with Special Functions . . . . . 168
Information about Seismic Hazards . . . . . 169
Mutual Aid, Emergency Planning, and Recovery and Reconstruction . . . 170
Mutual Aid . . . . . 170
Emergency Plans and Operations . . . . . 170
Recovery and Reconstruction . . . . . 171
Financing Policies . . . . . 172
Recommendations . . . . . 172
Legal Aspects of Seismic Safety . . . . . 174
Legislative Measures . . . . . 174
Administrative Procedures . . . . . 176
Emergency Powers . . . . . 177
Basic Concepts: Acceptable Risk and Priorities for Seismic Safety . . . . . 178
Defining Acceptable Risks . . . . . 178
Risk Levels That Should Not Be Exceeded . . . . . 179
Conclusion . . . . . 181

**PART THREE: SUPPLEMENTARY INFORMATION** . . . . . 183
Appendix A: History of Official State Government Involvement in Earthquake Safety . . . . . 185
Chronology . . . . . 185
Activities of Other State Agencies . . . . . 188
Appendix B: History of Earthquake Code Provisions and Regulations in California . . . . . 192
Early Research . . . . . 192
Santa Barbara and Palo Alto . . . . . 193
State Chamber of Commerce . . . . . 193
The Field Act . . . . . 194
The Riley Act . . . . . 195
City of Long Beach . . . . . 195
Los Angeles County . . . . . 196
City of Los Angeles . . . . . 196
Uniform Building Code . . . . . 197
Board of Fire Underwriters of the Pacific . . . . . 197
City of San Francisco . . . . . 197
Structural Engineers Association of California . . . . . 198
State Building Standards Commission . . . . . 199
Applied Technology Council . . . . . 199
Earthquake Engineering Research Institute . . . . . 199
Appendix C: Geologic and Seismologic Features of Earthquakes . . . . . 200
Ground Motion . . . . . 201
Surface Faulting . . . . . 201
Ground Failure . . . . . 201
Seismic Sea Waves and Seiches . . . . . 203
Appendix D: The San Fernando Earthquake Study . . . . . 215
Origin and Purposes . . . . . 215
Major Effects of the Earthquake . . . . . 215
Appendix E: Potential Earthquake Losses in the San Francisco Bay Area . . . . . 217
Appendix F: Senate Concurrent Resolution 128 (1969) . . . . . 218

# MEETING THE EARTHQUAKE CHALLENGE

## Part One:
## A Comprehensive Approach To Seismic Safety

## PREFACE

In preparing Part One we have relied on the thoughtful work of more than 75 people comprising the Joint Committee's five advisory groups. Their reports, compiled in Part Two, are based on nearly four years of study and discussion. Moreover, in the final stages each group reviewed and commented on draft versions of the reports of all the other groups. Accordingly the advisory group reports can be viewed as statements of substantial consensus on the principal policy needs for seismic safety and provide appropriate directions for future legislative and administrative action.

In this first part of the Joint Committee report we have attempted, to the best of our ability, not only to summarize but also to reflect faithfully the concepts, principles, and recommendations of all the advisory groups. The recommendations appear in two sections of Part One. (1) The section entitled "A Basic Legislative Package" is presented for critical consideration and enactment during the 1974 session of the California Legislature. The keystone of the basic legislative program—on which effective accomplishment depends—is the proposed California Commission on Seismic Safety. Other essential policies are also included in the basic legislative package. (2) Another section of Part One, entitled "An Additional Agenda of Critical Recommendations," presents further measures to be considered and implemented by a wide range of appropriate agencies, and especially by the proposed California Commission on Seismic Safety.

We wish to acknowledge the tremendous help we have received in our editorial and drafting efforts from the chairmen and members of the five advisory groups. Mark Peters, an accomplished editorial consultant, provided expert help in the preparation of these volumes. We pay particular thanks to Brynn Kernaghan, of Diridon Research Corporation, for administrative and coordinative work done always with good spirit and good will.

Finally, we acknowledge the indispensable help of Karl V. Steinbrugge in his role as Chairman of the Executive Committee, and as thoughtful and friendly critic of our writing efforts.

Our association with this entire enterprise has been a source of much satisfaction, and of only occasional frustration. We believe that the end result more than justifies the time and energy that a large number of people have contributed to this effort on behalf of earthquake safety.

Robert Olson
Assistant Director
Metropolitan Transportation Commission
Hotel Claremont, Berkeley

Stanley Scott
Assistant Director
Institute of Governmental Studies
University of California, Berkeley

Virtually all of our major urban areas are susceptible to earthquakes. *U.S. Geological Survey photo.*

## AN OVERVIEW: PUTTING IT ALL TOGETHER

California is situated in a seismically active region of the globe, and is laced with earthquake faults that spread over much of the State, including some of its most important urban areas. Consequently, virtually all of California is subject to earthquake shaking, and future earthquakes capable of producing great damage and disaster are inevitable.

Accordingly, the basic approach recommended by the Joint Committee on Seismic Safety is to (1) take all practicable measures that will reduce the present high hazard levels, and (2) avoid creating further hazards by discontinuing imprudent planning, building, and development practices. Such thoughtful seismic safety policies, if persistently pursued and diligently implemented, can bring dramatic reductions in California's earthquake hazard.

For this, the people and institutions of this State need to commit themselves to a comprehensive and long-term effort. The recommendations of the Joint Committee on Seismic Safety are intended to help martial the State's many resources into a thorough, systematic, and effective program.

### The Principal Earthquake Hazard: Works of Man

In broad overview, the works of man loom as the principal cause of earthquake hazard. In open country, one should be able to "ride out" a great earthquake in reasonable safety, barring landslides, large-scale liquefaction, and tsunamis. It is primarily the structures built in seismic regions that create the hazard.

Viewed this way, earthquake safety seems disarmingly simple to achieve. All that needs to be done is either leave the landscape untouched or prudently plan where to build, and design every structure and excavation to minimize any hazard created. Accordingly, the seismic safety implications of any proposed action should be evaluated and found acceptable before the action is permitted.

### Guidelines for Seismic Safety

These insights yield useful guidelines for seismic safety measures and policies:

First, thoughtful land use decisions are fundamental to seismic safety. We should make sure not to erect a structure on ground that is subject to high levels of seismic or geologic hazard, unless such construction is unavoidable, or the risk to life and property can be made acceptably low. Sometimes, of course, we are forced to build in areas of high hazard, such as across earthquake faults. A good example is the case of water mains. In such cases, we must use sophisticated and often expensive designs so that the structures and principal mains can accommodate substantial movement without loss of function. We should, moreover, also provide adequate back-up capacity and alternative temporary emergency facilities in case the use of the original facilities is lost.

Second, when contemplating grading or construction in seismic areas, one should first consider the stability of the underlying geologic formations. With ground of doubtful stability under earthquake conditions, building or grading should proceed only after all the likely consequences have been evaluated and approved by competent professionals.

Third, in a seismic region like California, decision makers should observe one invariable rule of thumb, namely, that every significant structure in California can be expected to undergo at least one major earthquake in its lifetime. All should therefore be located, designed, and built to withstand future shaking or ground failure in order to minimize possible death or injury and avoid unnecessary or unacceptable damage. In any event, no action should be taken that will raise the earthquake risk above levels that reasonable people would presumably consider acceptable. (See Table 1 for a suggested scale of acceptable risks.)

All of the above considerations are important, but the third is crucial. Every building should be made as secure against earthquake shaking as is practicable. To this end, no structure should be built unless the geologist, architect, engineer, and builder—as well as the community—are satisfied that it meets adequate standards designed to prevent life-threatening collapse or damage in future earthquakes.

## Performance: Past and Present

Past performance in seismic safety has clearly been inadequate. Estimates vary widely, but California has perhaps more than 100,000 unreinforced brick or hollow-tile buildings, most of them built before 1933. These buildings are prime earthquake hazards, most of them not having been specifically designed and built to withstand seismic forces. Further, recent earthquakes show that many other types of buildings fall substantially short of providing adequate seismic safety. Some modern buildings are hazardous, as demonstrated by the damage that Los Angeles County's brand new Olive View Hospital sustained in the San Fernando earthquake of 1971. Furthermore, we have continued to build on or across faults, and to erect high-rise structures under conditions that leave authorities fearing for the fate of occupants should an earthquake be followed by fire. Thus, not only has past performance fallen short of meeting the need for earthquake safety, but present performance is still clearly unsatisfactory in many respects.

Why has past performance been inadequate? The answer, basically, is that we have failed to implement what is already known about earthquake safety. The familiar economic pressures to "build now and hope for the best" are part of the explanation. Unawareness, wishful thinking, and preoccupation with day-to-day problems are also responsible. California's policy leaders, in other words, need to be much more concerned with the State's seismicity and the need for earthquake safety.

But the problem also relates to the role of professionals who should, in turn, be exercising more effective leadership. They should be constructively involved in the policy-making process, posing the issues, and supplying technical guidance to policy leaders in exploring alternative solutions.

We need more professionals who can provide such leadership. The "good" ones are overworked, and the others fail to understand, to care, or to communicate, or are too busy earning their daily bread. If we encouraged greater responsibility on the part of professionals, and made better use of the professional capabilities available, we could with present knowledge achieve respectable progress toward seismic safety. Accordingly, we appear to have been

most remiss in failing to ensure thorough, consistent, and forward-looking application of what we already know about earthquake-hazard reduction. We need to close the gap between knowledge and practice.

Thus, while we clearly need new earthquake legislation, we also need more and better-trained professionals, with strong motivation and ready access to policy makers. The following comments by respected and knowledgeable engineers during the Joint Committee's May 1972 earthquake conference in Sacramento are relevant to this point.

> Less than 20 percent of building designs cross the desk of an engineer competent to check them. Of those that are checked competently, half do not meet seismic safety standards.
>
> Failures to meet present codes are caused by: (1) not enough money for building inspection function, and (2) a hack attitude on the part of some professionals.*
>
> Substantial increases in earthquake resistance can be achieved with little increase in cost, if there is proper coordination on seismic safety measures and needs between architects, planners, engineers, and other professionals concerned with the location, design, and construction of buildings.†

## A Systematic and Responsible Approach

A systematic and responsible approach can help translate the guidelines for seismic safety into specific hazard-reducing measures. The community can reasonably be asked to adopt these measures, and otherwise implement them, if it is to deal responsibly with earthquake hazard.

Where do we go from here?

1. We must ensure that all who are directly involved in designing for earthquake safety—geologists, seismologists, planners, architects, engineers, builders, developers, and owners—are effectively forewarned about earthquake and geologic hazards that should enter into their decisions. They should have such hazard information on hand even before any contemplated structure reaches the design or site selection stages, in order to avoid possible misunderstanding. Good decisions with regard to earthquake safety require a full understanding of existing hazards and their implications for site selection and preparation, and for designing, building, equipping, and maintaining structures.
2. Full recognition should be given to seismic hazards when preparing general plans and land use regulations. This will enable land use control measures to play a vital role in minimizing future earthquake hazard.
3. In planning and designing structures, the participating professionals and owners need to engage in interdisciplinary communication during the design process, to ensure that their efforts are compatible, and mutually contribute to seismic safety.
4. We ought to make certain, through governmental controls, that building plans are reviewed by competent professionals to ensure that the designs and

* Robert W. Giese, Building Inspector, Contra Costa County.

† Carl B. Johnson, Consulting Structural Engineer, Los Angeles.

standards of construction called for will achieve acceptable levels of seismic safety. (See Table 1.) To this end, the design process should be monitored and checked to ensure that earthquake safety standards are met. The designers need someone looking over their shoulders to see that a good job is done.

5. Adequate inspection—independent of the designer—and enforcement should take place during construction to make sure that the earthquake-safety measures called for by the plans and specifications are carried out effectively, and that no on-the-job shortcuts create unnecessary earthquake hazards.

6. Preparedness plans and measures should be in readiness to guide the initial efforts that ought to be made when the inevitable happens and future earthquakes strike populated areas. Such measures must include the rescue and care of the injured, and the housing and feeding of survivors. They must include plans for recovery and reconstruction—plans outlined beforehand to prevent hasty rebuilding that may recreate old mistakes. They must include plans for economic recovery, and for aid to those who have suffered significant economic losses.

7. Financial rehabilitation measures may need to include a comprehensive disaster insurance program, with earthquake insurance a component part. At present, earthquake insurance is available but not widely purchased. Thus, most properties are uninsured. Moreover, as things stand now, the seismic region of California may be virtually *uninsurable* as a whole. The potential losses from a single strong earthquake are very great—on the order of $5-$50 billion—and there is no certainty that the next such earthquake will be delayed long enough for the insurance industry to build up adequate reserves to cover the losses.

Sketched in broad-brush fashion, these are the main outlines of the seismic safety measures that need to be taken. Looked at in summary form, they seem simple and straightforward. But getting them enacted and implemented will be a herculean, many-sided task, partly because of the wide range of interests, disciplines, professions, and organizations involved. Mostly, the problem is one of getting many different people and organizations to work together on aspects of a huge and complex enterprise that is still imperfectly understood. Accordingly, the job of fitting all the pieces together is the essence of the effort.

## The Proposed Program

The next major section in Part One of the Joint Committee report outlines a comprehensive, first-stage program of policies and actions that the committee believes should be enacted by the California Legislature and signed into law by the Governor. The single most important component of this "basic legislative package" is the creation of the California Commission on Seismic Safety. The other parts of the package are the tools needed by the seismic safety commission to do the job.

The third section in this part of the report is an additional agenda of critical recommendations; it outlines other measures that should be taken or explored by the proposed California Commission on Seismic Safety. The agenda assumes prior enactment of all components of the basic legislative package. The two together constitute a comprehensive program that the committee believes is essential to further substantial progress in seismic safety.

The concluding section of Part One discusses, in a general way, the role that government at each level can and should play in this entire effort.

| | | | |
|---|---|---|---|
| 1. | Extremely low[1] | Structures whose continued functioning is critical, or whose failure might be catastrophic: nuclear reactors, large dams, power intertie systems, plants manufacturing or storing explosives or toxic materials | No set percentage (whatever is required for maximum attainable safety) |
| 2. | Slightly higher than under level 1[1] | Structures whose use is critically needed after a disaster: important utility centers; hospitals; fire, police, and emergency communication facilities; fire stations; and critical transportation elements such as bridges and overpasses; also smaller dams | 5 to 25 percent of project cost[2] |
| 3. | Lowest possible risk to occupants of the structure[3] | Structures of high occupancy, or whose use after a disaster would be particularly convenient: schools, churches, theaters, large hotels, and other high-rise buildings housing large numbers of people, other places normally attracting large concentrations of people, civic buildings such as fire stations, secondary utility structures, extremely large commercial enterprises, most roads, alternative or noncritical bridges and overpasses. | 5 to 15 percent of project cost[4] |
| 4. | An "ordinary" level of risk to occupants of the structure[3,5] | The vast majority of structures: most commercial and industrial buildings, small hotels and apartment buildings, and single family residences. | 1 to 2 percent of project cost, in most cases (2 to 10 percent of project cost in a minority of cases)[4] |

[1] Failure of a single structure may affect substantial populations.

[2] These additional percentages are based on the assumption that the base cost is the total cost of the building or other facility when ready for occupancy. In addition, it is assumed that the structure would have been designed and built in accordance with current California practice. Moreover, the estimated additional cost presumes that structures in this acceptable-risk category are to embody sufficient safety to remain functional following an earthquake.

[3] Failure of a single structure would affect primarily only the occupants.

[4] These additional percentages are based on the assumption that the base cost is the total cost of the building or facility when ready for occupancy. In addition, it is assumed that the structures would have been designed and built in accordance with current California practice. Moreover the estimated additional cost presumes that structures in this acceptable-risk category are to be sufficiently safe to give reasonable assurance of preventing injury or loss of life during and earthquake, but otherwise not necessarily to remain functional.

[5] "Ordinary risk": Resist minor earthquakes without damage; resist moderate earthquakes without structural damage, but with some non-structural damage; resist major earthquakes of the intensity or severity of the strongest experienced in California, without collapse, but with some structural as well as nonstructural damage. In most structures, it is expected that structural damage, even in a major earthquake, could be limited to repairable damage. (Structural Engineers Association of California).

A seismic safety commission to do the job.

## A BASIC LEGISLATIVE PACKAGE

### California Commission on Seismic Safety

The State should establish the California Commission on Seismic Safety with responsibility and authority to develop seismic safety goals and programs, help evaluate and integrate the work of State and local agencies concerned with earthquake safety, and see that the programs are carried out effectively and the objectives accomplished.

**The Need for an Overseer Agency.** The work of both the Governor's Earthquake Council and the Joint Committee on Seismic Safety provides ample evidence for the following conclusions.

First, many different agencies and levels of government have substantial responsibilities in the fields of earthquake preparedness and seismic safety.

Second, there is a pressing need to provide a consistent policy framework for and integrate the activities of agencies at all governmental levels, a need not now being addressed by any governmental entity that has continuity and duration.*

Third, in the absence of an effective overview, many efforts are poorly coordinated, and inadequate progress is being made toward important safety goals, or the goals themselves are lacking.

Fourth, only through concerted and broad-gauge efforts, coordinated by a State-level overseer agency, can methodical, continuing, long-term progress be made toward higher levels of seismic safety. The proposed seismic safety commission could meet all these needs.

**Commission Functions and Makeup.** The commission should be responsible for the following in connection with earthquake-hazard reduction: (1) setting goals and priorities; (2) developing programs; (3) devising criteria and standards; (4) providing technical assistance; (5) monitoring performance, reviewing accomplishments, and recommending program changes; (6) reviewing reconstruction efforts after damaging earthquakes; (7) gathering, analyzing, and disseminating information; (8) encouraging research; (9) sponsoring training to help improve the competence of specialized enforcement and other technical personnel; (10) helping coordinate the seismic safety activities of government at all levels; and (11) ensuring compliance with standards.

To carry out its mission effectively, the commission would have to be given adequate powers, funds, and staff. The commission's role could be advisory, coordinative, and policy-making, but it should also have the power to order compliance with State standards. This power could be employed if any State or regional agency or local jurisdiction should fail, within a specified period of time, to implement and enforce sound seismic safety practices as adopted by the legislature or the commission. The commission would also be empowered to review, comment on, and approve seismic safety measures proposed for adoption by State, regional, and local agencies.

The commission should be principally representative of the public, served by a highly competent staff, and authorized to establish advisory groups representing appropriate professions, disciplines, and interests. A reasonable size for

* Neither the Governor's Council nor the Joint Committee is a continuing body.

the commission would be nine members. Five members could be appointed by the Governor, two by the Senate Rules Committee, and two by the Speaker of the Assembly. Their term of office should be four years, on a staggered basis.

### Land Use Planning Measures

Good land use planning measures constitute attempts to guide future development in directions considered appropriate and beneficial to the community while recognizing all relevant factors. Among the many relevant factors are geologic and earthquake hazards. It is clear that prudent land use planning, taking adequate account of what we know and can learn about geologic conditions and the effects of earthquake shaking can, in time, greatly reduce casualties, property damage, and other losses in future earthquakes.

Good land use planning must be a shared State-and-local function. Most basic zoning controls are lodged at the city and county level, where most land use planning decisions are actually implemented. However, the State is also unquestionably obligated to see that the overriding questions of public health and safety are given adequate consideration.

In this light, the Advisory Group on Land Use Planning identified two major kinds of State responsibility concerning land use in seismic hazard areas. Briefly, they are: (1) prudent planning and zoning to reduce future hazards, and (2) earthquake recovery guidance to ensure that post-disaster reconstruction programs do not re-create disaster situations. Accordingly, the achievement of much higher levels of seismic safety can be furthered by the early enactment of several measures, discussed below, designed to employ the powers and procedures of land use planning and land use control in reducing future earthquake hazard.

**Local Seismic Safety Elements.** The California Commission on Seismic Safety should be authorized and directed to review the progress and performance of local governments in incorporating adequate seismic safety elements in their general plans, and in enforcing compliance with those elements. If inadequacies are found, the commission should be directed to recommend legislation or other measures necessary to correct deficiencies of either performance or enforcement.

Legislation passed in 1971 required that local governments include seismic safety elements in their general plans, while legislation in 1972 provided for local progress reports on their adoption and implementation. But there is no provision for effective review of such reports, or for preparing and recommending corrective measures if progress and performance are found inadequate. In addition to requiring a suitable review of local progress toward seismic safety, the State should consider adopting policies designed to ensure that the zoning and public-building construction practices of cities, counties, and special districts are consistent with the seismic safety elements of their general plans.

**Geological Safety of Subdivisions.** Legislation should be enacted to ensure that any future subdivision or building activity of substantial scope be undertaken only with full cognizance of the geologic and soils conditions both in the general area and at the site of construction. Whenever there is any question about how stable the ground would remain during earthquakes, neither grading

The area shown in this 1965 photo has since been highly developed and is now covered by housing and many other structures. Improved land use planning would have minimized this hazard. *U.S. Geological Survey photo.*

nor building should be permitted until the question has been satisfactorily resolved by competent professionals in soils engineering and engineering geology.

Accordingly, the Subdivision Map Act should redefine subdivisions to include all divisions of land into two or more parcels, so that no future land-dividing activity may escape the geologic safety regulation proposed. Also, the Subdivision Map Act should require that cities and counties deny subdivision approval whenever there is reasonable doubt about the geologic-seismic safety of individual lots or of subdivisions. Further, the legislation should provide guidelines defining "reasonable doubt" with respect to geologic-seismic safety.

The Real Estate Practices Act should require that the State Real Estate Commissioner, on the advice of the Division of Mines and Geology or the local agency concerned, deny issuance of a real estate report whenever there is reasonable doubt about a subdivision's general geologic or seismic safety. Where such doubt applies only to individual lots, these could be specifically designated and excluded, without affecting the status of the entire subdivision.

The Subdivision Map Act should also require that any information on geologic hazards turned up for a given subdivision be recorded in the city or county offices and adequate reference to those facts be made on the face of the final subdivision or parcel map. Consulting geologists and soils engineers must certify the final maps, clearly indicating where geologically hazardous areas remain.

Cities and counties should be required to adopt regulations at least as restrictive as the basic State regulations, including provisions permitting the local governments and their building officials to require soils-geologic reports. These should include information on potential earthquake effects with respect to building and grading in the case of all sites subject to significant geologic-seismic hazards. The local code should also prohibit the issuance of building or grading permits if such action is likely to have any adverse effects on the site or on property outside the site.

These measures, utilizing subdivision, building, and land use controls, are necessary because most potential hazards created in the future would involve new building activity in new subdivisions or redevelopment areas. Moreover, in the face of California's continuing rapid urbanization, failure to improve our performance in forestalling the creation of new geologic and seismic hazards means that old mistakes will proliferate into new areas. Consequently, appropriate action prior to subdivision and construction can be extremely effective, at comparatively low cost, in avoiding this situation. It is essential, therefore, that land use controls for regulating subdivision and building activity be strengthened.

**Community Redevelopment.** The State Community Redevelopment Act should be amended to provide that geologic and seismic hazards be considered blighting conditions that might help to make a given area eligible for redevelopment. Moreover, adequate provision should be made for a post-disaster redevelopment process that could be instituted expeditiously following an earthquake. Present procedures are much too slow for reconstruction activities in a post-disaster situation. Disasters require reasonably prompt action, and, to be effective, the program applied must be based on careful advance contingency

planning prior to the disaster. Most local governments do not at present have adequate staff or resources for such contingency planning. Accordingly, the California Commission on Seismic Safety should be directed to explore the possibilities of using the community redevelopment process—as both a long-term hazard-reduction and postearthquake reconstruction tool—to advance the cause of seismic safety.

Through their normal planning, redevelopment, and disaster preparedness programs, local governments may be able to develop advance "sketch plans" for reconstruction, contingent upon the occurrence of earthquakes. Such sketch plans should be based on the estimated probable damage from earthquakes of various magnitudes and intensities. These plans should also designate areas where lower densities or open space are preferable to existing densities and uses. The recommended density reductions could guide reconstruction and relocation efforts after disasters.

By preparing such plans carefully and in advance of future earthquakes, communities and their governments could act methodically to avoid repeating old mistakes in the reconstruction process. The information developed as part of the program to abate hazardous buildings (discussed later) could serve as the basis for such contingency planning by indicating buildings and city areas where the most damage can be expected.

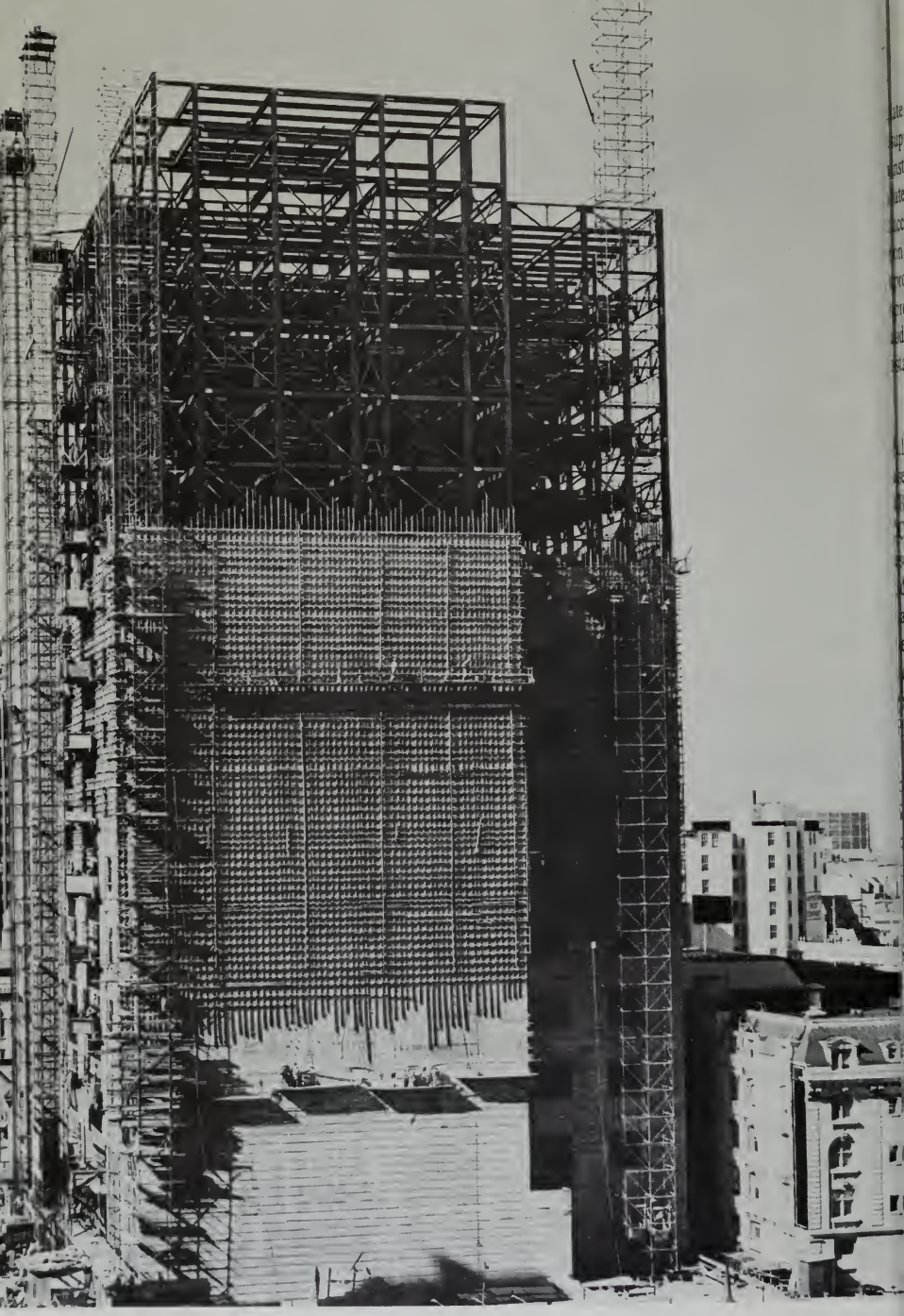
**Environmental Impact Reports.** Both legislative and administrative guidelines should specifically require that geologic hazards and seismic safety be considered in the preparation of environmental impact statements. In addition, environmental impact statements should be required for all projects that involve critical concern with respect to geologic hazards and seismic safety. The statements would be required for the first three levels of acceptable risk outlined in Table 1.

**Utilities in Planned Unit Developments.** The State should require that the ownership, management, and financing of small utility distribution systems, such as those serving cluster housing and planned-unit developments, be adequate to secure them against financial or administrative failure in case of earthquake damage. This kind of protection is necessary because the popularity and proliferation of cluster housing in these developments has spawned the growth of relatively untried mechanisms for managing common facilities and utilities. Often these are neither publicly owned nor the responsibility of the established large-scale privately owned utility and service companies. Instead, they are owned in common and managed by associations of community property owners. Such associations are clearly incapable of coping with disaster situations.

To mitigate this kind of problem, the State can do either of two things: (1) set minimum standards and guidelines for the design, location, ownership, management, and record-keeping of planned-unit utility systems; or (2) prohibit such systems from being operated by homeowners' associations.

## Building Construction

**Revision of Standards and Codes.** Under the aegis of the California Commission on Seismic Safety, the State should persistently pursue efforts to improve construction engineering standards and other code measures—especially



Adequate codes can provide excellent earthquake bracing.

teral-force requirements. This work should be done in cooperation with, and in ıpport of, the continuing efforts of relevant professional societies and ıstitutions of higher education. The revised codes should incorporate all the test data from seismic and structural engineering research, and should take into ccount the lessons learned from recent earthquakes. The California Commission n Seismic Safety should be given responsibility to review successive drafts of roposed code revisions, and to obtain advisory opinions from recognized rofessional experts on controversial points. The State should also provide dequate financial assistance to facilitate the expeditious revision of codes and andards.

**Enforcement Measures.** State legislation should—as a minimum—require that ll State and local jurisdictions abide by the lateral-force requirements and other eismically relevant portions of current codes, such as the latest Uniform uilding Code (UBC), and other codes as determined by the commission. The alifornia Commission on Seismic Safety should be authorized to establish eismic review panels in different areas of the State to (1) assist local building epartments in their review and approval of plans for construction; (2) monitor nd report to the California Commission on Seismic Safety on the adequacy of nforcement, standards, and performance; and (3) help establish, in the case of ritical facilities, acceptable criteria for seismic design and seismic bracing ystems. (The last point is discussed later under "Critical and High-Exposure acilities.")

Where it is determined that the necessary competence in seismic safety or ther specialized disciplines is not currently available to local jurisdictions, the tate program should help supply qualified personnel, working through the State r county governments, or those of the larger cities, to ensure acceptable levels f performance.

**Training and Protection of Professionals.** The California Commission on eismic Safety should ensure that adequate educational programs are available to rain and inform building officials and others with regard to seismic safety equirements. Moreover, the State should encourage educational and profes- ional development programs aimed at giving all engineering and other design rofessionals adequate training and information on the best methods of chieving seismic safety.

Reasonable protection against liability should be provided for geologists, ngineers (including structural, civil, and soils engineers) and other geotechnical onsultants, and public safety officials, performing under mutal aid agreements, vhose services are indispensible in seismic safety activities. Accordingly, the State should enact legislation to mitigate the present liability problem, which dversely affects professional persons working in specialized technical fields. Such legislative protection could include exemption from the rules of strict iability, amendment of the appropriate statute of limitations to ensure that iability commences when the work is done, and possible provision of a program f malpractice insurance. Geotechnical consultants who render services to public gencies should be protected to the same extent as other public employees.

All of these measures are essential for several reasons. First, the acknowl-

edged difficulties some professional societies have in agreeing on the cod revisions required to keep standards current argue strongly for State financia and other assistance. Such help can ease the accomplishment of these tasks Furthermore, codes and standards need to be updated regularly as nev knowledge becomes available, and as lead-time in the practical implementatio of new knowledge can be reduced.

Second, there is much evidence that many local jurisdictions, especially th smaller ones, do not have adequately trained personnel available for th plan-checking and other reviews necessary for effective code enforcement Without such personnel, there is no assurance of enforcement.

Third, many design professionals are not fully aware of the appropriat design criteria and other needs that must be met to build safely in seismi regions. And finally, existing liability laws create unacceptable risks fo professionals operating in their respective fields. To illustrate the point, few soil engineers or engineering geologists can qualify for or afford the insurance needec to provide adequate protection, while structural engineers, by the same token generally hesitate to perform damage inspections for public agencies.

## Abatement of Hazardous Buildings

The California Commission on Seismic Safety should be authorized anc directed to proceed immediately with a program of hazardous-building abate ment. Such a program is needed because little progress is being made on the greatest of existing hazards confronting Californians: the thousands of olc hazardous buildings in which people live and work. Moreover, it is known tha some newer buildings are also hazardous. Activities under the recommendec program should concentrate first on the older buildings and those in areas o known hazards. At the same time, the program participants would also inventory other more recent structures and work out a plan for the abatement of hazard found unacceptably high.

As an adjunct to the hazardous-building abatement program, the State should require local jurisdictions to formulate and enforce regulations leading tc the elimination of unsafe parapets, especially those on earthquake-resistan buildings.

**Dangerous Older Buildings.** As mentioned above, initial abatement acitivitie would concentrate on buildings constructed before 1933 or—in the case of any given jurisdiction—before some later date based on an evaluation of the history of locally applied design standards and enforcement. Buildings would be reviewed if they were put up before the designated date, and are of "Type III" construction, with unreinforced brick and masonry walls, and wood floors and roofs. Those failing to meet the commission's requirements would have to be brought up to standards or demolished under due process and rules outlined by the commission.

Judgments on hazardous-building abatement should take particular accoun of (1) the desirability of preserving historical and unique structures, (2) specia geologic and soils hazards, and (3) the socio-economic consequences of the attendant relocation and housing programs.

California has many thousand old hazardous buildings such as this one which was damaged in the moderate Santa Rosa earthquake of 1969. *San Francisco Examiner photo.*

**Inventory of Other Buildings.** During the abatement program for olde buildings, the commission could also conduct an inventory—perhaps on sampling basis—of all other types of potentially hazardous buildings. Th inventory would enable the commission to estimate the magnitude of the task of hazard reduction, to affix costs, and to estimate the number and kinds c personnel needed. The commission would be instructed to develop a realistic an workable program—staged over a number of years—for the abatement of a hazardous structures. Integral to the program would be finding ways to financ the effort.

## Critical and High-Exposure Facilities

It is essential to improve safety levels of facilities (1) whose continue performance is critical immediately after an earthquake, or (2) whose failu would cause significant numbers of injuries and perhaps substantial loss of lif Accordingly, both the State legislature and the California Commission on Seism Safety should carefully consider the need for more stringent safety requiremen for such critical and high-exposure facilities.

**Special Safety Measures.** State legislation should direct the Californ Commission on Seismic Safety to review and consider the effectiveness c seismic safety measures in the case of structures and facilities corresponding t the first three levels of acceptable risk listed in Table 1. The commission shoul use appropriate administrative measures to make sure the acceptable risk leve are not exceeded, and should recommend new State legislation where necessar to this end.

**Schools, Hospitals, and Emergency Facilities.** Special seismic safety measure have been taken with regard to public schools under the Field Act. The newl enacted Hospital Safety Act has extended similar protection to future hospital Both acts provide for State-level plan-checking and construction inspection t ensure compliance with the specified safety criteria. At the time of this writin legislation similar to the Field Act and the Hospital Safety Act, but applying t emergency service facilities, had been introduced and was under consideratio

**Other High-Exposure Facilities.** The legislature should also instruct th California Commission on Seismic Safety to make sure that other critical an high-exposure facilities are reviewed to determine whether their location, sit preparation, and building designs will effectively reduce the risk to acceptab levels.

The commission should be directed to establish a task force to review th safety of high-rise structures. This task force should examine and comment o plans for high-rise construction, with special attention to (1) collapse hazard, (2 performance of elevators, stairways, and mechanical and electrical facilitie during and after an earthquake, (3) fire hazard and fire safety measures, and (4 performance of nonstructural components undergoing earthquake stresses.

State legislation, to be implemented and enforced by the Office of the Stat Fire Marshal, should require that all buildings of high exposure includ acceptable plans and procedures for the evacuation of occupants or for th

lospitals and other critical facilities should be earthquake-safe.
*os Angeles City Fire Department photo.*

Dam failure can affect thousands. *Los Angeles Times photo.*

creation of safe internal environments in case of earthquake and fire. Issuance o building permits should be contingent on meeting these requirements. Th adequacy and probable performance of safety plans should be reviewe regularly.

A permanent State board should be established, having a continuin responsibility for: (1) advising the Division of Safety of Dams on the adequacy o standards of safety for structures under its jurisdiction; (2) determining whethe the division is adequately staffed to fulfill its responsibilities for public safety (3) checking that the necessary standards of safety are adequately enforced; an (4) advising on technical problems related to the safety of dams in California.

In the interest of minimizing hazards due to dams and reservoirs, th California Commission on Seismic Safety should be encouraged to review th program on dam safety—jointly with the Director of the Department of Wate Resources—in order to ensure that the best obtainable safety levels are achieved Moreover, the commission should be directed to review with all appropriat agencies the problem of achieving maximum downstream security from flood caused by earthquake damage to dams.

## Emergency Preparedness Measures

**Local Emergency Plans.** The Emergency Services Act should make i unmistakably clear that cities and counties are obligated to prepare and maintai emergency plans, consistent with the designations and criteria established by th State Office of Emergency Services (OES). Similar plans should be required o special districts, and of public utilities that provide essential services such a water, gas, electricity, and sewage disposal. Provisions should be made fo implementing the plans on a county or regional basis.

Formal procedures should be established for the review and approval of loca emergency plans by OES. The review should be comprehensive, thorough critical, and complete in a timely manner. The review process could also b employed by the State to help ensure that all local governments enact a adequate complement of disaster and emergency-related ordinances and reso lutions. In addition, greater incentives and help, in the form of money an technical assistance, are needed to stimulate local disaster preparedness efforts

**Disaster Exercises.** Emergency-plan testing and disaster exercises should b conducted at least once a year in each city and county, and in State and Federa agencies and the larger non public organizations. Short of an actual disaster, simulated-disaster exercise is the most effective way to learn about weaknesses i emergency operations plans, procedures, and resource systems. Disaster exercise should be an integral part of the preparedness planning and plan-review proces OES is the appropriate agency to assist in developing and coordinating disaste exercise programs, to receive reports, and to summarize the results of disaste exercise activities throughout the State. It should do these things in conjunctio with its review of local emergency plans, as proposed above. In addition, th legislature should require that all elementary, intermediate, and secondar schools conduct regular earthquake disaster drills.

The legislature should review the Emergency Services Act to ensure adequat coverage of enrolled or registered persons enlisted into service during a "loca

**Mobile base operation and vehicles responding to a disaster.**
*Los Angeles County Fire Department photo.*

emergency." There appears to be adequate coverage already in the case of a "war emergency" or "state of emergency," but some doubt remains with respect to the situation in a "local emergency."

**Emergency Funds and Resources.** The legislature should provide larger annual sums to the State Emergency Fund. The current level of $1 million is regularly exceeded by emergency demands and represents an unrealistic minimum. It should be increased to $5 million a year. The increase might be coupled with improved administrative procedures, including reimbursements to local governments for disaster-related expenses.

The value of mutual aid has been well established in the case of fire fighting and the legislature should therefore provide for the expansion of the Master Mutual Aid Agreement to cover other resources that might be needed immediately after a damaging earthquake. This could include the services of employees in law enforcement, public works, building inspection, public health and perhaps other fields. The program's value would also be enhanced greatly if a means were provided to reimburse local agencies for costs incurred when rendering aid to other jurisdictions.

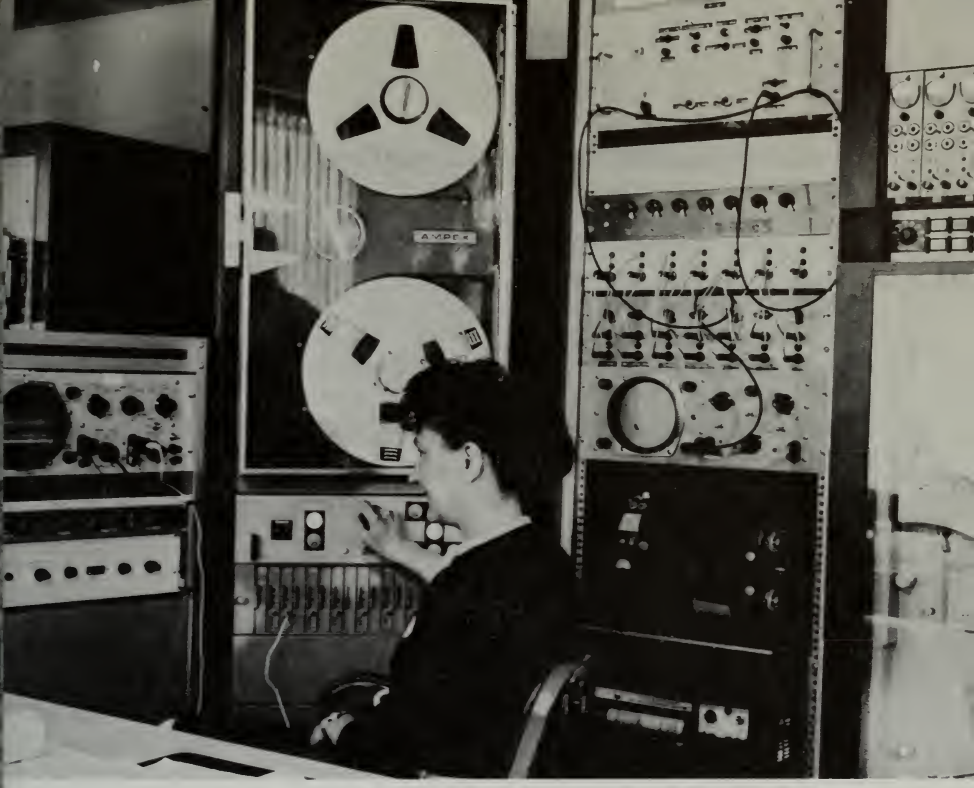
The legislature should commission studies to (1) evaluate the adequacy of public safety resources in our communities, and (2) develop techniques for establishing minimum standards for public safety services. Many communities are not adequately supporting their basic emergency resources. Consequently we must take measures to remedy this situation.

## Research

The State should support an expanded program of basic and applied research, directed toward: (1) a better understanding of earthquakes and seismic activity in general, and related geologic hazards; (2) the development of safer earthquake-resistant structures; and (3) improving the ability of local governments to respond effectively to earthquake disasters. Research funds should be appropriated and allocated to the universities and qualified technical and scientific groups for the following:*

1. Applied earthquake engineering research programs having specific objectives leading to improved earthquake-resistant structural systems, practical design methods, and reliable details of construction.
2. Increased support of geologic mapping by the Division of Mines and Geology.
3. Basic research in areas of geology and seismology related to faults and earthquakes.
4. Geodetic measurements to identify and delineate distortions of the land surface, both before and after earthquakes.
5. Monitoring of groundwater movements and examination of records from

* See the "Report of the Advisory Group on Engineering Considerations and Earthquake Sciences" in Part Two for a more detailed discussion of the areas of research that should be supported.



One aspect of seismic research: examining the recordings of the aftershocks of an earthquake. *U.S. Geological Survey photo.*

continuously recording surface-water-level gauges for indications of tectoni movements.

6. Postquake studies by competent State personnel in all relevant disci plines, to be made immediately after any moderate-to-great earthquakes, in any area of the world where such knowledge would be applicable to safety o geologic hazards in California.

7. Evaluation of the social, economic, psychological, and biological effects as well as any other significant consequences of earthquake disasters.

8. Intensive study of the requirements for including earthquake insurance in a national program of comprehensive disaster insurance, and the implementation of such a program.

## AN ADDITIONAL AGENDA OF CRITICAL RECOMMENDATIONS

The basic legislative package should be complemented by additional efforts whose cumulative effect can greatly advance the cause of seismic safety. The advisory group reports are a compendium of such recommendations whose exploration and implementation should be pursued by the proposed California Commission on Seismic Safety. Some of the most critical of these recommended measures are outlined below.

### Further Employment of Land Use Controls

1. Additional effort should be devoted to designating critical seismic areas such as fault zones. Such areas could be declared of critical statewide concern, and appropriate measures taken to regulate development by requiring special permits, setting aside open space in hazardous areas, and identifying hazards in general plans.

2. Zoning and building practices of cities and counties should be consistent with the seismic safety elements of their general plans. This goal may require monitoring and enforcement. Special zoning districts, such as open space or hazardous districts, should be employed where appropriate. Local agencies should employ "down zoning," or place existing properties in nonconforming status, where hazards are excessive. In extreme cases, temporary moratoria on the issuance of permits should be used.

3. Property reports should be required to be furnished by local governments to all prospective purchasers of real estate, and such reports should evaluate seismic and geologic hazards.

4. Public funding agencies should ensure that public investment decisions and capital improvement programs do not encourage development in hazardous areas without adequate precautions. Local agencies should consider seismic hazards when reviewing public and private improvement projects. Projects due to receive governmental funding or loan guarantees should be evaluated for geologic hazards before any financial commitments are made.

### Additional Design Measures for Seismic Safety

All structures designed for human use should be capable of withstanding a great earthquake (approximately 8.0, Richter scale) without collapsing or sustaining damage that could cause substantial injury or loss of life. Utility systems must be designed to resist earthquakes, and be capable of rapid restoration.

1. All jurisdictions should have adequate minimum construction standards for seismic safety. These standards should be reviewed, monitored, and where necessary, supplemented by the proposed California Commission on Seismic Safety.

2. Building design standards should be improved, and their application and enforcement strengthened.

3. Adequate seismic design standards must be developed for utility and communications systems.

## Furthering Preparedness, Response, and Recovery

California residents are entitled to an effective governmental response to disasters caused by damaging earthquakes. This requires Federal, State, and local commitment to comprehensive natural-disaster-preparedness, assistance, and recovery programs.

1. Community post-disaster reconstruction should begin as soon as practicable, but previous mistakes should be avoided and future hazards minimized. Disaster victims should be helped to secure prompt disaster benefits from equitably administered assistance programs.

2. Local agencies should identify available sources of competent assistance for inspecting damaged buildings. A statewide emergency medical care plan should be developed, capable of effective operation at the community level. In addition, the Emergency Services Act should give the county governments responsibility for coordinating intracounty local emergency operations (unless viable alternatives exist).

3. All barriers to the expeditious use of resources during disasters should be identified and removed. There should be assurance that every organization with an emergency service function would plan for and practice the use of available emergency communications facilities.

4. Preparedness and disaster response measures need more careful monitoring and periodic evaluation. There should be a continuing program to test disaster preparedness efforts, and all disaster preparedness plans—including the State Emergency Plan—should be accompanied by emergency action checklists and standard operating procedures.

5. Community plans to guide future reconstruction efforts should be prepared, taking into account all relevant factors that might affect future hazards, or that would improve the quality of life in the community. Federal, State, and private agencies should work with local governments and regional organizations in preparing such community reconstruction plans.

6. The following measures would help improve the effectiveness of disaster assistance programs:

   a. Public and private organizations should be supplied with information on available disaster services, and on appropriate procedures for obtaining them.

   b. Both State and Federal governments should review the disaster-assistance delivery systems.

   c. Local governments should cooperate with State and Federal representatives in planning for and establishing disaster assistance centers in damaged areas.

## Training and Education

All practicing professionals whose work is in any way related to the question of seismic safety should be aware of that relationship, and should be informed on all appropriate safety measures. Moreover, all California residents should have a basic knowledge of earthquakes and be reasonably informed about living with seismic risks.

1. Professional development should be encouraged through conferences and seminars, courses of instruction, special programs, and possible certification criteria for those engaged in structural design and construction.

2. Specialized personnel with competence in seismic safety or sophisticated forms of earthquake-resistant construction should be made available to all local building officials. In the principal urban areas, this should be done by augmenting the local staff or using consultants. Where such skills are not regularly needed, resource personnel could be made available on contract from neighboring metropolitan areas, State agencies, or professional organizations. In the case of critical buildings, special review panels could participate in establishing design criteria, examine and approve preliminary designs, and evaluate the adequacy of seismic bracing systems.

3. Adequate rescue training should be available throughout the State. Intensive training should be provided for local public safety and public works employees in connection with rescue activities needed after an earthquake.

4. Greater public awareness of earthquakes and seismic safety should be stimulated. Suggestions include an annual "Earthquake Preparedness Day," improvement of school curricula and use of earthquake drills, and imaginative employment of the communications media (e.g., films, fliers, pamphlets, radio and television spot announcements, and instructions printed in telephone directories).

### Earthquake Insurance

1. All new borrowers who are purchasing one- to four-family residential buildings should be required by lending institutions to have earthquake insurance, just as is the case for fire insurance.

2. State government should actively work with the Federal Government and appropriate industry organizations to determine if a program of comprehensive national disaster insurance is needed, including earthquake coverage, and if so, to develop such a program. The main focus of these efforts should be on the creation of additional risk-bearing capacity.

## GOVERNMENTAL ROLES IN SEISMIC SAFETY

In concluding our discussion, let us examine one of the more pervasive and crucial items, namely, the question of the roles and performance of government at the various levels in the quest for seismic safety.

### The State Government

As the principal governing entity of a major population subject to severe earthquakes, California's State government has a crucial role to play. Thus the State government has the ultimate non-Federal responsibility for the health, welfare, and safety of Californians, and accordingly is obligated to take measures adequate to the need.

These measures must include working with the local governments to help and encourage their seismic safety efforts, and to improve their performance where this is needed. In addition to aiding and encouraging local governments along these lines, the State can and should take other more direct actions, where necessary. Seismic safety in California should be treated as a State-and-local government partnership. But wherever local government performance falls short of full acceptability, the State must obviously assume the role of senior partner. Neither logic nor the well-being of California's citizens would be served by any other view.

Accordingly, the proposed California Commission on Seismic Safety would provide a focal point at the State level for the development of required policies and implementation of needed improvements.

In addition, the State Development Plan and the State Environmental Goals and Policy Report, and any similar statewide comprehensive plan or policy documents required in the future, should contain items of official policy on seismic safety, including, possibly, the identification of major fault zones and statement of the criteria and standards that should be applied in all such zones.

The State must also assume major new roles in the areas of planning review and approval if it is to help ensure that local plans and regulations properly recognize seismic safety considerations. In this capacity, local agencies would be encouraged to adopt and enforce local plans and regulations conforming to and carrying out the State seismic safety standards and program. Furthermore, the State would assist and advise the local agencies, and review and monitor their performance, before initiating more stringent enforcement measures.

Another State function should be to provide the necessary guidance, technical assistance, and other support for jurisdictions needing help in coping with problems related to seismic safety.

Finally, the State must see to it that its seismic safety regulations are applied uniformly in charter cities and counties as well as general-law cities and counties. Moreover, it must emphasize that the regulations also apply to all State agencies and all special districts. However, no local jurisdiction should be precluded from adopting and enforcing higher seismic safety standards than those specified as a minimum by the State.

## ocal Government

The principal governmental resource at the site of any potential disaster is sually that of a local government. Consequently, local agencies will of necessity e heavily involved in preventive actions, as well as in the immediate n-the-scene response to disasters. This fact, coupled with our strong local ome-rule tradition, suggests that local government will continue to be the imary agent for direct action in resolving seismic safety problems.

Because local government constitutes such a principal resource, the matter of s performance is of statewide concern. Accordingly, one consideration high on ie agenda of the California Commission on Seismic Safety would be the ovision of continuing help to local governments, as necessary, to facilitate and nsure the best possible performance in the interest of seismic safety.

## egional Bodies

Between the State and local governments are logical areas for activity by ngle and multipurpose regional agencies. In fact, single-purpose regional rganizations are increasingly important in most metropolitan areas. The anning and other programs of such regional organizations—like the Southern alifornia Rapid Transit District, the San Francisco Bay Area's Metropolitan ransportation Commission and Bay Conservation and Development Commis- on, and California's State and regional coastal commissions—can help signif- antly to advance the cause of seismic safety.

Moreover, if and when multipurpose regional governments are created in one more metropolitan areas, promotion of seismic safety should be an integral rt of their funtions, programs, and plans. Meanwhile, the roles of existing luntary associations of governments—the Association of Bay Area Govern- ents, the Southern California Association of Governments, the San Diego unty Comprehensive Planning Organization, and others—could be strength- ed by requiring that they (1) identify and propose solutions to seismic safety oblems, (2) make sure regional planning programs consider earthquake hazard nditions, and (3) employ seismic safety considerations when evaluating local d regional projects under the grant review process.

Finally, the function of the county-level local agency formation commissions AFCO) with respect to seismic safety planning should be made explicit. The mmissions are developing a role as basic long-range governmental planning ganizations in each county. They must review and approve all proposals for e incorporation of new cities, the development of new communities and ecial districts, the annexation or exclusion of territory, and the dissolution of cal governments.

Thus, LAFCOs clearly have the power to stop agencies providing water, nitation, and other municipal-type services from annexing territory (as well as taching it). Moreover, LAFCOs can prevent the formation of new municipal- pe service agencies where none existed before. These are strong powers with uich the LAFCOs can discourage development in hazardous areas. The mmissions should fully recognize and utilize these powers to minimize seismic d geologic hazards.

## The Federal Government

Of all the governmental jurisdictions in the United States, that at the Feder level is the largest, has traditionally the ultimate responsibility for the gener welfare, and possesses the greatest supply of fiscal and other resources. As consequence, it generally plays the primary role in minimizing disaster effec and maximizing recovery from disasters, whether this is done through loar grants, insurance, or provision of matériel and large-scale application manpower and organizational resources.

The California Commission on Seismic Safety should be both respectful ar forthright in pointing to the need for Federal action and Federal program especially where problems are too big for State and local government California, or where the Federal Government can play key catalytic regulatory roles that will help reduce the earthquake hazard or spread the ris

The Federal Government can help in many ways, including the following:

1. No applications under Federal grant, loan, and revenue sharing prograr should be either submitted or approved unless there is a demonstration th seismic and geologic hazards have been considered, and adequate steps taken minimize them. For example, where State or local land use policies a insufficient, Federal standards should be employed as guides; grant program such as for new towns, should encourage development in low-risk instead high-risk areas; and federally approved or subsidized programs should he reduce existing hazards and avoid creating new ones.

2. Programs and procedures providing funds for post-disaster reconstructio should be improved so as to ensure that their release is conditioned upo adequate standards of seismic safety.

3. Federal encouragement and financial support of basic and appli research in seismic safety should be continued.

4. Development of a system of natural-disaster insurance, that wou protect property owners and reduce hazards by encouraging future building safe locations and according to earthquake-resistance standards, should i pursued with vigor.

5. The Federal Government should take the lead in establishing a Nation Disaster Preparedness Program that is conceptually sound, clearly defin objectives and programs, determines the appropriate roles of all levels government, and includes criteria for performance and means for its measu ment.

# MEETING THE EARTHQUAKE CHALLENGE

---

## Part Two:
## Advisory Group Reports

# INTRODUCTION

Part Two of the Joint Committee's final report contains the individual ports prepared by the committee's five advisory groups. Each of these reports esents the specific recommendations arrived at by the members of the group, ong with detailed discussions giving pertinent information and arguments in pport of the recommendations. Additional information of a supplementary ture is provided in Part Three. Taken together, then, Part Two and Part Three the Joint Committee report constitute what may be considered resource aterial for Part One.

The publication of the Joint Committee's final report climaxes some four ars of study and research. The recommendations and proposals resulted from ns of thousands of hours of expert volunteer and staff investigation, followed critical review. While it is not expected that all of the recommendations will implemented immediately, it is hoped that each will be considered and acted on over the next few years. After 1974, the burden of this responsibility will st with the proposed State seismic safety commission—should it be estab- hed—as well as with those concerned legislators and individuals who have so adfastly supported the work of the Joint Committee.

By way of further introduction—and with an eye toward putting the entire dertaking in an even clearer perspective—the following pages present some ckground material on the Joint Committee and its major accomplishments to te.

## istory and Authority

California's Joint Legislative Committee on Seismic Safety was established in 969 to "develop seismic safety plans and policies and recommend to the gislature any needed legislation to minimize the catastrophic effects upon the ople, property and operation of our economy should a major earthquake rike any portion of California."* The formation of the Joint Committee was e direct result of concerned professionals expressing a need for organized udy and effective implementation of safety programs throughout the State. any of these professionals had already made substantial contributions to terdisciplinary earthquake efforts in the past, and viewed State-level action as e next logical step, since local enforcement of seismic safety measures had not en effective. An informal meeting in Berkeley by the University of California's stitute of Governmental Studies in 1969 resulted in the introduction of Senate ncurrent Resolution 128 by Senator Alfred E. Alquist. The legislature lopted this measure as a statement of policy, and thereby acknowledged the ate's clear responsibility to provide for the safety of its residents.

While the enabling legislation emphasizes the study of earthquake-related oblems in the San Francisco Bay Area, it manifests a concern for seismic fety throughout the State as well. The San Fernando earthquake of 1971 rther validated this position, and the committee has focused on problems mmon to both northern and southern California.

*SCR 128 of 1969 (Resolution Chapter 378); see Appendix F in Part Three of this report.

## Organization

The Joint Committee is composed of eight legislators, four senators and fou assemblymen, with representation from both the northern and southern parts o the State. Senator Alfred E. Alquist chairs the panel with Assemblyman Jin Keysor serving as Vice Chairman. The other current members are Senator Joseph Kennick, Alfred H. Song, and James E. Whetmore, and Assemblymei Leroy Greene, Richard Hayden, and Paul Priolo.

The Joint Committee has continued to rely on the technical expertise o more than 70 advisors, including the professionals instrumental in establishin the committee. The five advisory groups and their assignments, as specified i SCR 128, are as follows:

*Advisory Group on Engineering Considerations and Earthquake Sciences*

This group shall review available scientific and engineering knowledge relative to the reduction of the risks of damage due to earthquake and related geologic hazards. It shall make recommendations to the committee based upon its findings. Its judgement in the fields of engineering and earthquake sciences shall guide all other advisory groups. It shall review the progress of reports of all other advisory groups and may recommend such changes, elaborations, or new directions as may appear desirable. It shall provide, insofar as feasible, technical information and opinions on submitted questions to other advisory groups.

*Advisory Group on Disaster Preparedness*

This group shall be responsible for reviewing and evaluating the adequacy of existing disaster plans insofar as they relate to the probable consequences of disastrous earthquakes. The group should give special emphasis to the development of plans to marshal human, physical, and economical resources necessary to minimize human and material losses flowing from earthquake disaster, and to facilitate restoration of the normal life of the region as expeditiously as possible. The group should recommend pre-earthquake measures that will help to minimize human and material losses flowing from earthquake disaster.

*Advisory Group on Postearthquake Recovery and Redevelopment*

This group shall be responsible for recommending a series of general contingency plans to guide the long-term work of recovery, reconstruction, relocation where desirable, and redevelopment. The plans shall include variable courses of action based upon the several parameters of earthquake location, duration, intensity and damage.

*Advisory Group on Land Use Planning*

This group shall determine the limitations that should be placed upon the use of land subject to seismic hazard for appropriate inclusion in the land use plans of state, regional, and local governments.

*Advisory Group on Governmental Organization and Performance*

This group shall study local government organization so as to determine how the plans formulated by the other advisory groups to reduce the risk of loss due to earthquake disaster may best be carried into effect. It shall recommend modifications in existing government organization so that local government jurisdiction is sufficient to enable it to exercise the requisite authority to make the emergency measures effective. It shall recommend new governmental institutions should they appear essential.

The composition of the advisory groups is also outlined in SCR 128 and ovides for a broad base of representation including individuals from other rthquake-oriented organizations. Advisors are appointed by Chairman Alquist serve on a volunteer basis.

An Executive Committee composed of the chairmen of each of the five visory groups, and others involved in specific projects, makes policy decisions d handles administrative concerns for the advisory groups within the idelines established by the Joint Committee. Professor Karl V. Steinbrugge, e of the prime movers behind the creation of the Joint Committee on Seismic fety, chairs the Executive Committee.

By March 1970 each advisory group had met to elect officers, identify eliminary objectives, and establish tentative schedules. Since mid-1970, each the advisory groups and the Executive Committee have met monthly to aluate progress, prepare and review individual reports, make policy and value dgements, and conceptualize and review legislative and administrative recom-endations. In-house hearings have helped to provide liaison between the oups.

Liaison between advisors and the Joint Committee has been accomplished the Advisory Group Executive Committee, topical hearings, distribution of visory group minutes, the committee newsletter, and memoranda from airman Alquist.

## ajor Accomplishments

**San Fernando Earthquake Study.** The San Fernando Earthquake of 1971 orded the Joint Committee an opportunity to investigate a local earthquake depth with the objective of applying the results to all of California. cordingly, a special subcommittee was established to carry out the necessary udy.*

In the course of its work the subcommittee issued three reports: July 31, 71 Preliminary Report; October 31, 1971 Interim Report on Earthquake sk; and the final report, The San Fernando Earthquake of February 9, 1971 d Public Policy. The recommendations presented by the subcommittee's nsultants in the final report have served as a basis for much of the legislation e Joint Committee has introduced.

*For a further discussion of the subcommittee, see Appendix D in Part Three of his report.

**Legislation.** The Joint Committee has influenced the activities of many disaster-related organizations through public hearings and investigations into earthquake safety programs. Although the primary effort has been directed toward preparing the final statewide seismic safety plan, a number of items of legislation—considered too important to be delayed—have also been presented. Among the urgent items of legislation, 14 out of 26 introduced by Senator Alquist to date have been adopted into law. Of special interest are major bills covering hospital construction, strong motion instrumentation, faultline zoning, seismic safety element, and emergency service structures. Outlined below is a brief synopsis of the various earthquake-related measures introduced since the committee's inception.

The following were proposed during the 1971 session of the legislature:

1. **Senate Bill 351 - Seismic Safety Element**

Status: enacted (Chapter 150).

SB 351 requires that all general plans consider the following: (a) a land use element, (b) a circulation element, (c) a housing element, (d) a conservation element, (e) an open-space element, and (f) *a seismic safety element* consisting of the identification and appraisal of seismic hazards.

2. **Senate Bill 352 - Hospital Safety**

Status: died in Senate Committee on Finance; reintroduced as SB 519 and passed into law (Chapter 1130) in 1972.

SB 352 requires that plans for hospital construction or alteration be made by a structural engineer and a licensed architect. It establishes earthquake resistance standards for hospitals, and provides for approval of the plans and inspection of hospital construction and operation by the State Department of Public Health through its contract with the Schoolhouse Section of the Office of Architecture and Construction in the Department of General Services.

3. **Senate Bill 479 - Public School Siting**

Status: enacted (Chapter 913).

SB 479 requires a geologic investigation of prospective sites for new schools and for additions to existing schools. Sites investigated within the last five years are exempted.

4. **Senate Bill 778 - Local Building Department Records**

Status: enacted (Chapter 616).

SB 778 requires that the building department of a city or county maintain as public records plans of the buildings for which that department has issued permits.

5. **Senate Bill 1206 - Active Faults**

Status: dropped in Senate Committee on Governmental Organization; reintroduced and passed into law as SB 520 (Chapter 1354) in 1972.

SB 1206 directs the State Geologist to delineate a zone along active faults and requires that all structures to be constructed within that zone be approved by the State Geologist on the basis of geologic and engineering reports.

6. **Senate Bill 1374 - Strong-Motion Instrumentation Program**

Status: enacted (Chapter 1152).

SB 1374 directs the California Division of Mines and Geology to organize, purchase, install, and monitor instruments in representative structures and geological environments in the State.

7. **Senate Concurrent Resolution 84 - State Capitol Status**

Status: passed (Resolution Chapter 233).

SCR 84 requests that the State Architect evaluate the safety of the West Wing of the Capitol Building and determine the costs of reconstruction to meet earthquake-resistant standards.

The following were introduced during the 1972 session:

1. **Senate Bill 519 - Seismic Structural Safety of Hospitals**

Status: enacted (Chapter 1130).

SB 519 requires that the State Department of Public Health, through a contract with the Department of General Services, develop hospital construction standards and regulations, assume responsibility for overseeing construction, and perform structural plan-checking, and such periodic review of operating hospitals as required to assure adequate resistance to earthquake damage. It also calls for the creation of an advisory building safety board.

2. **Senate Bill 520 - Alquist-Priolo Geologic Hazard Zones Act**

Status: enacted (Chapter 1354).

SB 520 expands the membership of the State Mining and Geology Board, and instructs that body to prepare policies and criteria for the development of designated special studies zones encompassing major active fault traces. Additional fees are charged to those applying for building permits for sites within such zones and the revenues are split by the State and local jurisdictions. The State Geologist shall prepare maps of those zones for use by local and State government.

3. **Senate Bill 689 - Clarification of School Building Sites Bill of 1971**

Status: enacted (Chapter 332).

SB 689 makes clarifying changes in the requirements established by SB 479 (1971) concerning geologic and soils investigations for school building sites.

4. **Senate Bill 895 - Clarification of Strong-Motion Program of 1971**

Status: enacted (Chapter 664).

SB 895 makes clarifying changes in the requirements established by SB 1374 (1971) concerning the basis for fee collection and administration by local jurisdictions of the strong-motion instrumentation program.

**5. Senate Bill 896 - Dam Safety**

Status: enacted (Chapter 780).

SB 896 requires that owners of dams designated by the State Office of Emergency Services (OES) prepare inundation maps and submit them to appropriate local public safety agencies and OES. Local jurisdictions affected are required to prepare emergency evacuation procedures based upon such information.

**6. Senate Bill 897 - Assessment of Geologically Hazardous Lands**

Status: held in Senate Revenue and Taxation Committee for interim study.

SB 897 would establish procedures whereby property owners could obtain reduced property assessments based upon geologic reports submitted to the assessor, providing the owner agreed not to develop such property for the areas determined to be unsafe.

**7. Senate Constitutional Amendment 42 - Assessment Valuation**

Status: held for interim study.

SCA 42 is a companion bill to SB 897. It allows the legislature to provide for reassessment of damaged property after the lien date for a given tax year.

**8. Senate Constitutional Amendment 76 - Legislature's Disaster Powers**

Status: held in Assembly Rules Committee.

SCA 76 extends to natural disasters the situations in which the legislature can convene and fill the offices of deceased members.

**9. Senate Concurrent Resolution 66 - Capitol Visiting Restrictions**

Status: held in Senate Rules Committee.

SCR 66 prohibits guided tours of the West Wing of the Capitol, prohibits entrance to the wing by persons under 18 without a waiver, and requires posting of warning signs of structural danger at entrances.

The following were introduced in 1973:

**1. Senate Bill 308 - Update of Cross-References in Hospital Bill of 1972**

Status: enacted (Chapter 189).

SB 308 corrects code cross-references in SB 519 (1972) made inapplicable by the passage of subsequent 1972 legislation reordering the Health and Safety Code.

2. **Senate Bill 424 - Assessment Valuation**

Status: held by author in Senate Revenue and Taxation Committee.

SB 424 is similar to SB 897 of 1972 and provides for immediate reassessment of damaged property provided its use is appropriately revised.

3. **Senate Bill 1266 - Revision of Dam Safety Bill of 1972**

Status: enacted (Chapter 762).

SB 1266 amends SB 896 of 1972, requiring only one inundation map at full capacity and stipulating that OES, rather than dam owners, will distribute the maps to public safety officials.

4. **Senate Bill 1372 - Future Emergency Service Structures**

Status: will be heard in Senate Committee on Governmental Organization in January 1974.

SB 1372 provides for the development of construction regulations for future emergency service structures by the State Office of Architecture and Construction. Enforcement is to be at the local level. Appeals procedures are also provided for.

5. **Senate Bill 1373 - Mandate of Local Disaster Plans**

Status: will be heard in Senate Committee on Governmental Organization in January 1974.

SB 1373 mandates local disaster plans which are now optional. OES is charged with establishing criteria and checking local plans for compliance with the State disaster plan. OES would report yearly to the legislature on the status of the plans.

6. **Senate Bill 1374 - Existing Emergency Service Structures**

Status: held by author in Senate Committee on Governmental Organization.

SB 1374 provides for bringing existing emergency service structures up to code (SB 1372) when funds are available from State and local bonds.

7. **Senate Bill 1375 - New Equipment in Emergency Service Structures**

Status: held by author in the Senate Committee on Governmental Organization.

SB 1375, the final bill in the "Emergency Service Structures" series forbids the installation of new Federal or State-funded communications and/or disaster equipment in any structures not meeting the standards established in SB 1372.

8. **Senate Constitutional Amendment 13 - Assessment Valuation**

Status: held by author in Senate Revenue and Taxation Committee.

SCA 13, a companion bill to SB 424, permits the legislature to establish regulations regarding assessment of damaged property.

**9. Senate Joint Resolution 4 - Federal Earthquake Research Funds**

Status: passed (Resolution Chapter 94).

SJR 4 memorializes the President to assure Californians that Federal earthquake research funds will not be cut back due to any reorganization of Federal agencies. The bill calls for a 10 percent increase in research funding.

**10. Senate Concurrent Resolution 77 - Extend Life of Joint Committee**

Status: passed (Resolution Chapter 190).

SCR 77 extends the life of the Joint Committee to run concurrently with this legislative session (ending December 1974).

**Conferences and Hearings.** Special concerns of the Joint Committee and its advisors have been discussed at conferences and hearings.

Of major importance was the committee's Conference on Earthquake Risk held in September 1971. Top technicians from across the country discussed means of evaluating risk and determining the level of acceptable earthquake risk as a basis for developing public policy. The insights and guidelines developed at this conference have proved valuable as the committee's work continued. (The conference proceedings have been published under the title, *Earthquake Risk – October 31, 1971, Interim Report of the Special Subcommittee on the San Fernando Earthquake Study.)*

In May 1972 the committee held an in-house conference to discuss various topics of interest to the advisory groups. Ideas presented at this conference appear in discussions throughout this report, and some are—as already indicated—being implemented through legislation and administrative action.

Hearings have been called by the committee as dictated by interest and the need for data. In January and February of 1972, the committee heard testimony by the San Fernando Study consultants on soils and dams, geology, land use planning, engineering, government response, lifelines, and disaster preparedness.* In an October 1972 hearing, the seismic hazards associated with high-rise buildings in the San Francisco Bay Area were examined. The following January, a similar hearing was held in Los Angeles.†

The earthquake on December 24, 1972, in Managua, Nicaragua, provided another opportunity for studying the reaction of buildings and soils to a moderate temblor. While much of the construction in Managua falls short of California code requirements, the buildings that were well constructed provided good subjects for study by the Joint Committee.

**Other Activities.** The Joint Committee has concentrated on working in cooperation with all other disaster-oriented agencies. Advisory group membership was originally determined with such continual liaison in mind. And, more recently, the committee has maintained close coordination with the Governor's

* *Hearing on Dam Safety,* held in Los Angeles, January 6, 1972; *Hearing on the San Fernando Earthquake,* held in Los Angeles, February 9, 1972.

† *Hearing on High-Rise Buildings,* held in San Francisco, October 29, 1972; *Hearing on High-Rise Buildings,* held in Los Angeles, January 12, 1973.

arthquake Council on both legislative and administrative matters. These two oups are designing a successor body to carry on upon their termination in 974. Both the Joint Committee and the Governor's Council recognize that ere must be a continuing effort to support earthquake research and to develop id implement effective seismic safety programs and resources.

By way of individual efforts, Senator Alquist has had the opportunity to ersonally inform a number of organizations and many individuals about seismic afety programs in California. He has spoken before such groups as the Western onference on Disaster Preparedness, the National Association of Engineering eologists, the Structural Engineers Association of California, the UCLA onference on Earthquakes, and the U.S. Atomic Energy Commission. Various embers of the Joint Committee and its advisory groups have also given expert stimony before several State and Federal Government committees.

# Report of the Advisory Group on Engineering Considerations and Earthquake Sciences

## ADVISORY GROUP ON ENGINEERING CONSIDERATIONS AND EARTHQUAKE SCIENCES

Clarence R. Allen
Professor of Geology and Geophysics
California Institute of Technology
1970 - 1974*

Clifford J. Cortright
Division Engineer, Div. of Safety of Dams
State Department of Water Resources
1970 - 1973

Henry J. Degenkolb
Consulting Engineer
1970 - 1974

Charles D. DeMaria, *Vice Chairman*
Structural Engineer
H. J. Brunnier Associates
1970 - 1974

Gordon W. Dukleth
Division Engineer, Div. of Safety of Dams
State Department of Water Resources
1973 - 1974

George O. Gates
Consulting Geologist
1970 - 1974

Richard H. Jahns
Professor of Geology
Stanford University
1970 - 1974

Carl B. Johnson
Structural Engineer
Johnson & Nielsen Associates
1970 - 1974

John F. Meehan
Research Director, Supv. Structural Enginee
Structural Safety Section, State OAC
1970 - 1974

William W. Moore
Sr. Consulting Partner
Dames and Moore, Consulting Engineers
1970 - 1974

Gordon B. Oakeshott, *Chairman*
Geologist, Active Faults and Earthquakes
1970 - 1974

Joseph Penzien
Professor of Structural Engineering
University of California, Berkeley
1970 - 1974

H. Bolton Seed
Professor of Civil Engineering
University of California, Berkeley
1970 - 1974

George Simonds
Professor of Architecture, Emeritus
University of California, Berkeley
1970-1974

Karl V. Steinbrugge †
Structural Engineer
1970 - 1974

*Dates of service

† Also chairman of the Executive Committee

## INTRODUCTION: STATE POLICY

It has been quite properly pointed out that the development of State policy not the exclusive prerogative of any one branch of government – executive, islative, and judicial branches all establish policy by their actions and cisions. In August 1969, the California Legislature passed Senate Concurrent solution 128, which opened with the statement: "The State of California has ositive interest in minimizing the disastrous effects of earthquakes. . . ." The nt Legislative Committee on Seismic Safety was immediately appointed. mpted by the need for a broadly coordinated approach to the reduction of thquake hazards, the Governor's Earthquake Council was appointed in uary 1972. The primary thrust of the council has been directed toward ions which may be taken administratively by all types of public and private ities, whereas the primary objective of the legislature's committee has been proposal of earthquake-damage reduction legislation to increase public safety l reduce economic loss. Additionally, ten State agencies presently have inite responsibilities in this area, and many local political subdivisions have ved into action.

Historically, the State has been involved in earthquake safety considerations rmittently (see Appendix A) since appointment of the State earthquake estigation commission after the San Francisco earthquake in 1906. During rvening years there has been a history of cooperative efforts between rnmental and private organizations directed toward mitigation of the public osure to geologic hazards. The development of criteria for safer design and nstruction of public schools, is one example of such cooperative effort. The vernor and the legislature have recently and clearly expressed their intent vard minimizing earthquake hazards. From time to time the third branch of rnment – the judicial – has been involved in the legal aspects of earthquake blems and thus has also had a hand in determining overall policy.

The Advisory Group on Engineering Considerations and Earthquake Sciences ieves that the State should accept basic responsibility for action to increase earthquake safety of its citizens.

Although the State should assume the role of leadership in stimulating and rdinating earthquake research and earthquake-hazard reduction programs, programs developed should make maximum use of the capabilities and erience wherever they may exist, either from organizations in the private tor, or from the public sector.

We recognize that the goals of some of the following recommendations may accomplished by administrative action and others may require legislation. n as we frame the recommendations, administrative action is setting some in ce. This is a highly desirable development.

## SUMMARY OF RECOMMENDATIONS

1. A State commission on seismic safety should be established.
2. Appropriate engineering standards and code revisions should be formu lated.
3. A State board on dam safety should be established.
4. A program for the abatement of hazardous structures should b instituted.
5. Laws pertaining to development and environmental impact should b amended as necessary.
6. The State Public Utilities Commission should set up regulations to assi in the maintenance of lifeline services during earthquakes.
7. The State should actively work with the Federal Government and th insurance industry to develop a complete, orderly program of natural disast insurance.
8. Consideration should be given to establishing a continuing, low-pressu educational program on the subject of earthquakes for the general public.
9. The State should augment its plans for disaster preparedness an postearthquake recovery measures.
10. The State should support an expanded program of basic and appli research aimed at providing data essential to minimizing seismic hazards an developing safer structures; financial support of earthquake engineering resear at the University of California should be increased.

## STATE EARTHQUAKE COMMISSION

We recommend that a coordinating State agency, such as the seismic safety mmission proposed by the Advisory Group on Governmental Organization and rformance, be set up to facilitate the accomplishment of earthquake-hazard luction tasks. This body should replace the Joint Committee on Seismic fety and the Governor's Earthquake Council upon their termination.

## STRUCTURAL STANDARDS AND CODES

### vision of Existing Requirements

All current seismic codes are based on the Structural Engineers Association California (SEAOC) publication, *Recommended Lateral Force Requirements d Commentary.** There is an urgent need for a major revision of this cument to incorporate all of the latest research findings and the practical sons learned from recent earthquakes. The revised document should then ve as the basis for the recommended minimum seismic design requirements of building-code agencies within the State.

It should be the responsibility of the State of California to provide the cessary funds, with assistance from the Federal Government in financing this ort.

SEAOC has incorporated the Applied Technology Council (ATC) for the rpose, among other things, of revising its code recommendations. The revised de should recognize (1) the differences in performance of various structural terials, (2) the differences in various foundation materials and types of ndations, (3) the varying importance of different building occupancies and ictions, and (4) the importance of the architectural (non-structural) portions a building.

Sites for critical, unusual, or major buildings should be subjected to special smological, soils engineering, and geological investigations. Where appropriate, ilding design should incorporate dynamic structural concepts and criteria that y – for the sake of simplicity – not have been incorporated into the code.

The Structural Engineers Association of California together with others luding universities, State agencies, and other concerned groups, should set up cialized working committees to constantly review research and new data tinent to seismic safety. Their purpose would be to keep codes current and to nsmit the revisions to State and local governments and code-writing bodies. te agencies not subject to building codes, such as the Department of Public rks (Highways), the Department of Water Resources (including the Division Safety of Dams), the Department of Industrial Safety, and the Department of blic Health, should review their standards relating to site selection, construc-n requirements, and operations and incorporate the best information with

eismology Committee, Structural Engineers Association of California SEAOC) *Recommended Lateral Force Requirements and Commentary,* 1967.

regard to seismic safety into those standards and regulations. Some form of Stat interdepartmental review or advisory board should monitor such review, as wel as the adoption of standards and the effective use thereof.

The State, through the university and college systems, through its agencies and through professional organizations should foster the professional develop ment of all building and structure professionals to educate and inform them a to current techniques of achieving seismic safety, and the technical bases of th various standards and provisions.

The quality of review and enforcement of local building regulations shoul be enhanced, possibly through increased building-permit fees. Since a buildin code must, of necessity, be a relatively simple statement of a very comple problem, special seismic review panels should be set up in different areas of th State to assist local building departments in their review and approval of plans These panels should assist in the preliminary architectural-structural engineerin planning, participate in establishing seismic design criteria, and review th seismic bracing systems for critical buildings.

State regulations should require that the design professional of record fo any building review the progress of construction to make sure that his design an plans are being properly interpreted and executed.

All State agencies shall require proper earthquake-resistant design in a State-owned facilities, including State colleges and universities, and specify tha this requirement shall be met for all facilities whenever State funds are directl or indirectly involved. There should be an independent review of compliance.

The State should recommend that Federal legislation be enacted requirin that all construction by Federal agencies at least comply with minimum loc building code provisions for earthquake resistance.

### Training of Building Officials

The State, through the university, college, and junior college system through its agencies, and in cooperation with the appropriate profession organizations, should provide programs to train building officials in th requirements of seismic, fire, and general construction safety. Building officia should be required to have the necessary training and experience in these are to fulfill their duties adequately. In many parts of the State, a specialize competence in seismic safety or in sophisticated forms of construction may n be readily available to the local building official. In such cases, suitably qualifi personnel should be available to the local agency and should be provided at co through the State, the county, or larger cities.

## SAFETY OF DAMS

With regard to the safety of dams in California, we recommend the llowing:

1. A permanent State board should be established with a continuing sponsibility for (a) advising the Division of Safety of Dams on the adequacy of fety standards for structures under its jurisdiction, (b) determining whether ie division is adequately staffed to fulfill its responsibilities for public safety, ) checking that the necessary standards of safety are adequately enforced, and l) advising on technical problems related to the safety of dams in California.

2. An appropriate State agency should be designated to evaluate the safety f dikes, levees, and seawalls throughout the State.

## HAZARDOUS STRUCTURES

Older structures constitute one of the major hazards to life and property ecause most of these were not designed to be earthquake resistant. Because of ie huge investment that society has in these structures, the benefits of any placement or reinforcement program must be weighed against the social cost f displacing persons and centers of employment — often involving low-income oups — as well as other economic considerations. Consequently, any program f alleviation of hazard will have to be phased over a considerable length of time.

We therefore recommend the following:

1. The State should adopt legislation encouraging or, if necessary, forcing unicipalities to formulate and enforce regulations leading to elimination of nsafe parapets.

2. State legislation should be introduced to systematically diminish the mber of hazardous old buildings through (a) State programs of financial sistance to local jurisdictions, and (b) tax incentives for building owners to courage their cooperation and active participation. Priority should be given ith regard to increasing earthquake safety, to the worst buildings in the worst cations and with the greatest occupancy, to structures needed in an nergency, and to public structures.

3. The State should conduct an inventory to determine the number and lue of the buildings in California that are deficient in providing a reasonable egree of earthquake safety. This inventory should probably include buildings at rious safety levels — not merely the worst — for a picture of the overall oblem in the State.

4. The State should evaluate for seismic safety, structures other than ildings — such as dams, bridges, highways, towers, and airports — and take ch corrective action as may be indicated.

5. Regulations should be promulgated — probably through the building des — to restrict changes to higher occupancy levels in hazardous buildings.

## DEVELOPMENT AND ENVIRONMENTAL IMPACT

In the general area of land development, we recommend the following:

1. The Real Estate Practices Act should be amended to permit the Rea Estate Commissioner to deny a permit for a subdivision where there i reasonable doubt that adequate seismic safety can be achieved.

2. The State Community Redevelopment Law should be amended wit respect to the definition of a blighted area to permit the redevelopment of area in which seismic or other geologic hazards are present. Redevelopment fund could then be used for clearance projects following an earthquake.

3. Legislation requiring environmental impact statements, and the revie procedures for such statements, should be studied with respect to the inclusio of seismic safety factors.

## LIFELINE SERVICES

The State Public Utilities Commission should set up regulations requirin that public utilities adopt suitable designs and procedures for the maintenance o lifeline services during earthquakes and ground failures so as to minimize loss o life, danger to public health, and interruption of communications. Maintainin the flow of energy, water, sewage, transportation and communication at a times is essential. A standing expert advisory board on earthquake engineerin established by the PUC, could help it in the technical aspects of maintainin utilities lifelines during earthquakes.

## INSURANCE AND LAND-TITLE PROBLEMS

The State, through its appropriate existing agencies, should actively wo with the Federal Government and the insurance industry to develop comprehensive and orderly program for providing natural-disaster insuranc including earthquake insurance as part of the package.

The Federal program presently underway needs to be accelerated by acti State support.

Further appropriate legislation is needed toward the resolution of land-tit problems that may be faced by property owners as a result of shifts in proper lines accompanying an earthquake.

## INFORMATION AND EDUCATION

With regard to State activities for communicating knowledge about seismic ety, our recommendations are as follows:

1. The State should provide funding and strong leadership in the coordina- n and dissemination of earthquake-hazards information. The Division of nes and Geology should act as the State clearinghouse for all geological and smological information related to the attainment of seismic safety. The vision should also organize a program for routinely informing local and State ficials, as well as the public, about new developments relevant to seismic ety.

2. The State should encourage universities, colleges, and concerned profes- nal societies (e.g., Earthquake Engineering Research Institute, American ciety of Civil Engineers, SEAOC) to develop suitable conferences, programs, d courses on seismic safety for engineers, architects, planners, and local vernment officials. Funds should be made available for key State officials to end conferences anywhere in the world where information applicable to lifornia's problems may be obtained.

3. Services relating to seismic safety — such as geological, architectural, gineering, and management advice, as well as construction inspection, and ucational programs — should be made available through the appropriate State encies to local jurisdictions and to other State agencies.

4. Consideration should be given to setting up a continuing, modest, w-pressure educational program designed to impart some understanding of rthquakes and their effects on manmade structures to planning commissioners, y councilmen, and other local government officials, as well as to the general blic.

## DISASTER PLANS AND OPERATIONS

1. The State should augment present disaster preparedness and postearth- iake recovery measures through its existing agencies and its current relation- ips with local governments.

2. The State should develop a framework for earthquake-disaster planning identifying the critical needs and matching them with the available assistance; isting comprehensive disaster plans must be brought closer to actual nergency operations in the field.

3. The State should provide a realistic comprehensive plan for earthquake saster response; this plan must actively involve local governments.

4. The State should act to set up standing civil and military orders for flying w-level photo-reconnaissance missions over areas affected by any major rthquake as soon as possible after it occurs. This would aid in an appraisal of e damages, potential hazards, and other effects resulting from the earthquake.

5. The State should develop a workable system for law-enforcement mutual d in conjunction with the California Council on Criminal Justice. Efforts ould be made to simultaneously increase both natural disaster and civil sturbance preparedness through the development of statewide capabilities to ndertake special law enforcement task force operations.

## RESEARCH

The State should support an expanded program of basic and applied resea aimed at providing data essential to minimizing seismic hazards and develop safer structures. The data should include information on seismicity in general well as specific information obtained from telemetered seismographic netwo and from instruments in wells. It should also include information on faulti source mechanisms, energy transmission, ground-motion characteristics, tsu mis, dynamic properties, and dynamic response and failure characteristics manmade structures such as dams, embankments, buildings, bridges, tow nuclear plants, and refineries, as well as underground, floating, and submer structures.

The University of California has on its staff many of the outstanding expe in the field of earthquake research; it also has some of the finest testing facilit available, including the recently completed shaking table for dynamic testing. therefore recommend that the State greatly expand its financial support earthquake engineering research at the University of California.

We further recommend that State support of research encompass the ite outlined below and that research funds be appropriated and allocated directly the universities, State agencies, and qualified technical and scientific grou involved.

1. There should be support for applied earthquake-engineering resea programs having specific objectives leading to improved earthquake-resist building systems, practical design methods, and reliable details of constructi Among the many critical areas of applied research are:

a. The interaction between soils and building foundations and sup structures. (There is a need to develop methods for evaluating the influe of local soil conditions on ground response during earthquakes, and consequences for the design criteria and safety of structures.)

b. The response of various types of building systems to earthqua motions.

c. The development of improved and simplified methods for evaluat the ability of dams to withstand safely the effects of earthquake motions.

d. The physical testing of building assemblies and building compone by simulated earthquake motions. (Construction of a large-scale, thr component, earthquake-simulating platform at the University of Califor at Berkeley would be desirable.)

e. The testing of structural details and connections in mason concrete, steel, and wood.

f. Testing of various materials and connections with regard to ductil and cyclic loading.

g. The study of methods for repairing earthquake damage to vari building materials and connections.

h. Damage control for non-structural (i.e., ornamental, mechani electrical) parts of buildings.

2. There should be increased support of geologic hazards programs, w particularly intensified efforts in geologic mapping by the Division of Mines a Geology. This should include the mapping and classification of faults and fa

es, the production of seismicity maps, and the mapping and delineation of as of landslides, fault creep, and land subsidence. Seismic risk maps of the te should be developed and kept up to date with the latest data from all ilable sources. Urban geologic mapping should be increased to serve as a or source of data for the recognition and appraisal of geologic and seismic ards, including faults and related earth movements.

3. Support should be provided for basic research in geology and seismology ted to faults and earthquakes. This would cover such things as the origin and chanisms of faulting and earthquake movement, the structure of the earth's st in seismic areas, and the generation and propagation of tsunamis, seiches, groundwater changes. Research on rock and soil mechanics, on the causes and ure of rock fracture within the earth, on the response of different rocks to ng seismic motion, and on the behavior of soils and rock under dynamic ding is particularly important. Also in this general category would be studies the mechanics of ground failure – especially landslides – during earthquakes, the development of methods for identifying areas where slide movements y occur during earthquakes.

4. There should be support for geodetic measurements to identify and ineate distortions of the land surface, both before and after earthquakes.

5. There should be support for the monitoring of groundwater movements examination of records from continuously recording surface-water-level ges for indications of tectonic movements.

6. There should be sponsorship of postearthquake studies by competent te personnel in all relevant disciplines, to be made immediately after any derate-to-great earthquake in any area of the world where such knowledge ld be applicable to safety or geologic hazards in California.

7. There should be support for coordinated studies of the biological effects earthquakes to document changes in ecological conditions.

# Report of the Advisory Group on Disaster Preparedness

## ADVISORY GROUP ON DISASTER PREPAREDNESS

Francis B. Blanchard
Consulting Civil Engineer
1970 - 1974*

W. Bryce Connick
Fire Chief
City of Watsonville
1970 - 1974

James T. Davis
Disaster Services Coordinator
County of Los Angeles
1970 - 1971

Henry K. Evans
Vice President and Consulting Engineer
Wilbur Smith & Associates
1970

E. A. Federspiel
Building Engineer
Pacific Telephone and Telegraph Co.
1972 - 1974

Loren D. Fields, *Vice Chairman*
Manager, Emergency Planning Program
State Office of Emergency Services
1970 - 1974

Robert W. Giese
Assistant Building Inspector
County of Contra Costa
1970 - 1974

Richard F. Gordon
Former Director, Disaster Services
American Red Cross
1970 - 1974

Matthew Hall, Jr.
Division of Emergency Health Services
Department of Health, Education and Welfare
1971-1972

Terry Haney
Program Manager
System Development Corporation
1970 - 1974

Charles C. Henderson
Medical Doctor
1970 -1971

Robert E. James
Chief Administrative Officer
City of San Fernando
1971 - 1974

William Jensen
Assistant Chief Deputy County Enginee
County of Los Angeles
1970 - 1971

Henry J. Lagorio
Professor of Architecture
University of California, Berkeley
1971 - 1974

James E. McCarty
Director of Public Works
City of Oakland
1970 - 1974

Noble F. Miller
General Engineering Supervisor
Pacific Telephone and Telegraph Co.
1970 - 1972

Richard Miller
Senior Associate
Wilbur Smith & Associates
1970

Edward M. O'Connor, *Vice Chairman*
Director of Building
City of Long Beach
1970 - 1974

Robert A. Olson, *Chairman*
Assistant Director
Metropolitan Transportation Commissi
1970 - 1974

William H. Parness
City Manager/Director of Civil Defense
City of Livermore
1970 - 1971

Lawrence Snell
Director, Institute for Disaster Prepared
University of Southern California
1972 - 1974

Robert C. Stevens
Regional Director
Federal Disaster Assistance Administrat
1972 - 1974

Mark Tanaka
California Hospital Association
1972 - 1974

Earl J. Taylor
American Institute of Architects
1970 - 1971

* Dates of service

# INTRODUCTION

## ıe and Purpose

This report brings together work accomplished during a four year period. In tion to our specific recommendations, we have included some background rmation which has helped the members in their work and might be of tance to the reader. This element consists of an introductory section that ıdes a statement of the main objective of our recommendations, a set of ıitions, a general discussion of the preparedness and response environment, ria for assigning priorities to the recommendations, and explanatory ghts on their proposed implementation. This section is followed by the mmendations themselves.

Our recommendations are divided into four major categories: (1) Planning Disasters; (2) Strengthening Operating Capabilities; (3) Evaluating Perform-; and (4) Minimizing Future Disaster Problems. Each recommendation ıdes a discussion that explains why we are making the proposal, and a brief ment about the priority it should have, how it should be implemented, and the general cost implications are.

n formulating our recommendations, we have held one principal objective in l: to strengthen the capability of the people of California—through their rnmental and private institutions—to mitigate the effects of and respond ctively to earthquake disasters.

## nitions

n order to avoid confusion about certain commonly used terms in this rt—which people sometimes use interchangeably—we have adopted the wing list of working definitions.

*Disaster Preparedness:* Activities, generally based upon planning programs formal plans, which contribute to the readiness of people, operational ems, and facilities—particularly those having emergency functions—to survive operate under disaster conditions and to perform effectively in the ediate post-disaster environment.

*Disaster Planning:* The process of preparing guidelines, policy directives, and edures for officials to use in preparing for and conducting disaster ations. Plans contain authorities, responsibilities, organizational relation-s, and operating procedures necessary for the accomplishment of disaster ed activities. Planning does not necessarily denote readiness.

*Disaster Operations:* Actions taken at the time of the disaster—and for a ed period of time thereafter—to restore order and public safety, to provide necessities for life and health, to restore essential services to the population ne stricken area (even if on a temporary basis), and to initiate assistance rams.

*Disaster Direction and Control:* The control of organizations and the ction of operations to cope with disaster problems by those formally onsible and those assuming informal leadership. A process by which essential rmation is obtained, priorities are established, and decisions are made.

*Disaster Assistance:* Post-disaster actions taken to restore the normalcy and nomy of the stricken area and to alleviate long-term hardships.

## The Preparedness and Response Environment

"Disaster" is the label given to occurrences involving the destruction of and/or property of such magnitude that it requires extraordinary organizatio responses. Moreover, the responses sometimes must be made in an uncertain a threatening environment. Preparedness alone cannot avoid the disaster, l effective disaster preparedness can "normalize" the impact of the disaster ways that will help response organizations survive and operate effectively.

This section identifies the primary factors influencing the degree preparedness of organizations, summarizes some of the principal characteris of the response environment, and outlines some potential disaster effects a other factors which can influence the operations of organizations hav emergency responsibilities.

**Preparedness of Organizations.** Preparedness is a function of several fact as outlined below.

### 1. Relationship to Normal Activities.

The duties of fire departments, law enforcement agencies, hospitals, public utility organizations involve them in limited emergencies almost o daily basis. Such institutions usually demonstrate the best response in la disasters.

### 2. Relationship to Geographic Area Served.

Most local governments experience major disasters only rarely, if at The State is almost continually involved in monitoring crises, responding emergencies, or aiding in disaster recovery. Some agencies of the Fed Government are involved continually in a multitude of emergency probl throughout the country. It appears that the scope of activities and specialization of disaster management increase partly as a result of the size of area for which the agency is responsible.

### 3. Disaster Vulnerability

The State in recent years has been involved in problems associated v flood, earthquake, fire, snowstorm, civil disturbance, wind, pollution, landsl mudslide, and tsunami occurrences. Some local regions, such as the Los Ang metropolitan area, seem to be almost continually involved in emerge activities. The level of preparedness in a given jurisdiction is partly a functio policy decisions based on the perceived vulnerability to and experience v disasters.

### 4. Commitment to Disaster Preparedness Activities

California is one of the better prepared states in the U.S. partly bec its experience with disasters has demanded a relatively high level of commitm to this specialized area of public management.

### 5. Resources for Emergency Planning and Operations

Preparedness is highest in those organizations and geographic areas where urces have been sufficient to establish and maintain an effective planning gram, emergency operating systems, and means of inter-organizational rdination. This commitment has been reinforced where such systems have ven their value in actual emergency operations.

**Response Environment.** Responding effectively to disasters does not stitute "business as usual," and people must make decisions and organiza- s must perform their emergency missions in an uncertain environment. The cipal characteristics differentiating the normal from the emergency operating ronment include the following:

### 1. Exercise of Unusual Powers

Declarations of emergencies and disasters often expand existing author- ; or invoke new ones, the operation of which can be unfamiliar to the public cial. The lack of knowledge can be accompanied by inadequate operating ems necessary to effectively implement the decisions made on the basis of emergency authorities.

### 2. Crisis Decision-Making

The compressed time for decision-making; a relatively high degree of ertainty about the situation; the tensions associated with long hours, poor rmation, conflicting demands, the lack of training in crisis decision-making personal anxieties; and other similar factors place added strains on public cials who must make emergency decisions.

### 3. Intergovernmental Administration of Public Programs

Intergovernmental relations improve in the disaster response environ- t because routine procedures and constraints tend to simplify or break n. Many organizations representing several spheres of government with ering authorities, resources, operating procedures, and political constit- cies must work together to solve common problems.

### 4. Demands, Resources, and Priorities

Generally, the public looks to government for emergency assistance, and re the number of people involved is limited the resources are usually quate. For instance, on a normal day a broken water main will be repaired ively quickly, but when several thousand such problems emerge simulta- usly what kinds of decisions must be made? Major disasters create real blems plus expectations and demands for assistance far in excess of the urces immediately available. Deciding who gets what, when, and why omes very critical considering the essentiality of some of the services.

### 5. Adequacy of Information and Communications

Although part of the decision-making system, the communications

process deserves special mention because in every disaster there are signific problems in getting situational information, evaluating its reliability, commu cating within and among the organizations involved, and insuring that decisi are relayed to the point of implementation. Part of this is due to inadequ emergency information systems, and part of it is due to the overloading of damage to existing equipment.

**Factors Affecting Performance.** A variety of physical, organizational, other factors affect the ability of emergency organizations to respond effectiv to disasters. Some are disaster related and some are not. Preparedness minimize the impact of some of these on emergency operations, but performance of the organizations involved will be determined to a large ext by the influence of such things as: (1) damage to their own facilities, equipme and resources; (2) loss or absence of personnel; (3) effectiveness of comma control, and information systems; (4) adequacy of emergency operating pl procedures, authorities, material and manpower resources, and means coordination; (5) recency of disaster experiences; (6) weather conditions; geographic factors; and (8) time of day or week, and special situations such weekends and holidays.

## Assignment of Priorities

The assignment of priorities is our means of emphasizing the rela importance of the recommendations. Four criteria were used in determin these priorities: (1) *special urgency* was given to some recommendations beca implementation would solve an immediate problem or be of long-te significance; (2) *sequence dependency* required that action on some recomm dations be initiated or accomplished before others could be considered; *current opportunities,* such as available funding and other forms of public government support, were recognized and influenced the priority of sc recommendations; and (4) *relative importance* was considered by classify proposals as essential or desirable.

## Implementing the Recommendations

The implementation of these recommendations will involve many people organizations. Each recommendation includes a brief statement suggesting w we think is the most appropriate mechanism for insuring that it is carried c These proposed assignments were based on some broader consideratic including:

1. The concept of a State seismic safety commission. Although the propo for such a commission is dealt with in detail by other groups, we interpret potential roles to be policy-making, programming, and regulatory in natu Recommendations that might best be implemented by such a commission are indicated. In these particular cases, an alternative is suggested so implementat could begin immediately or be considered if a commission is not established.

2. The relationship of the recommendation to the functions of an exist organization; e.g., the State Office of Emergency Services (OES), universit local governments, and so on. Wherever possible, such assignments have b suggested. In the case of OES, we recognize that effective implementation can

mplished only through an expanded role of the agency in the field of ster preparedness. The analysis of the programming, legal, personnel, and ncial implications of these recommendations is more the province of the cutive Branch.

3. The roles of Federal departments and agencies in seismic safety. Since a ber of reorganization plans are in various stages of implementation at the of this writing, we chose to indicate potential Federal involvement by the se "appropriate Federal agency." We would prefer to have been more ific, but our hope is that within the Federal Government there is a focus, as the Federal Disaster Assistance Administration and Office of Manage- t and Budget, that will review all of the suggestions presented by the Joint mittee on Seismic Safety and see that those involving the Federal ernment are considered.

4. The apparent need for different types of temporary or permanent king groups to examine and resolve particular problems. In most cases these ps should be established and terminated, where applicable, by existing ncies. Some considerations, particularly in the field of disaster preparedness, eyond seismic problems, and for that reason we have suggested such things "permanent intergovernmental working group" that by implication would seismic safety representatives involved. We are not recommending any new ncies, except for lending our support to the establishment of a State seismic ty commission.

## DISASTER PLANNING

The recommendations in this section focus primarily on improving process by which disaster plans, operating procedures, and similar materials prepared. This approach was based on an early determination that improving effectiveness of the process would be of long range significance. Th suggestions relate to planning information, authorities and guidance, geograp considerations, and particular topics that should be addressed to a greater exte by disaster plans.

### Authorities and Policies

**1. Emergency Authority Information.**

The Compendium of Legislation of the California Emergency P should be reissued with corrections annually, and a survey should be made insure that all State laws pertaining to disasters are included in it.

*Discussion.* Declarations of emergencies and disasters often expa existing authorities or involve the exercise of special ones. Sometimes pub officials are not familiar with these authorities, and this can retard effect action. Part of the cure lies in insuring that all authorities related to disas activities are identified, compiled, and analyzed. The list of those currently effect with appropriate commentary should be distributed regularly.

Local jurisdictions would then be assured that their programs are based current statutes. To be fully effective, local jurisdictions should make cert that all proclamations, resolutions, and other official documents needed exercise these authorities are in existence before any disaster.

*Priority and Implementation.* This is a medium-priority recommen tion. It should be implemented through the State Office of Emergency Servic (OES) with the assistance of the Attorney General's Office. This would be a lo cost item.

**2. Local Emergency Ordinances.**

The State should insure that current and comprehensive local emergen ordinances are in existence in all local jurisdictions.

*Discussion.* Authority for local governments to act in response to natu disasters and/or other extraordinary emergencies is derived from the Californ Emergency Services Act and local ordinances adopted pursuant to this act. O provides guidance for the preparation of local emergency-related ordinances a resolutions and maintains the State's file of such documents.

While the act provides the legal basis for such local ordinances, it does n require that a county, city, or special district adopt such measures or submit t documents to OES; nor are there any specific provisions for keeping su ordinances current. However, effective local planning cannot be accomplish without a suitable legal basis.

Along with amendment of the Emergency Services Act to require lo emergency plans, Article 10 of the act should be amended to include

uirement for comprehensive and current local (including special districts) rgency ordinances. OES should provide an initial draft of amending language he Legislative Counsel for preparation of a final bill to amend the act. It is ortant that special districts have the legal responsibility to coordinate their ster plans with the jurisdictions they serve.

*Priority and Implementation.* This is a high-priority item which should nplemented through the State legislature. Costs would be low.

**3. Mutual Aid Program Improvements.**

The existing mutual aid program should be strengthened and its icability should be broadened so as to be more effective.

*Discussion.* The underlying concept of mutual aid is valid, and the rating experience in fire suppression activities has demonstrated its value. We e found that several measures would improve the effectiveness of the gram and that its application could be broadened to provide a means of hanging other skills that might be needed in an earthquake disaster.
Specifically, we suggest the following:

(1) State funds should be available to reimburse local agencies for direct costs incurred as a result of providing aid to other jurisdictions.

(2) All local disaster plans should include procedures for requesting mutual aid assistance and integrating such assistance into operations.

(3) Local mutual aid agreements should be expanded to cover the use of law-enforcement, building-inspection, public-works, and other personnel with critical post-disaster skills.

(4) A careful identification and distribution of information about legal liabilities and protections that mutual aid agencies might encounter in other jurisdictions should be completed.

(5) The concept of paying mutual aid costs through some form of insurance or "line of credit" available to local jurisdictions should be explored.

(6) Programs to educate local government decision-makers about types of assistance available and the means of requesting it should be integrated and expanded.

*Priority and Implementation.* This is a high-priority item which should implemented by the legislature. The cost implications of this should be died further.

**4. Maximizing the Use of Resources**

Strong efforts should be made to identify and propose solutions to all nning, jurisdictional, legal, and procedural barriers to the effective use of ources in response to a disaster.

*Discussion.* The Governor of California must certify, in requesting that a ajor disaster" be declared by the President, that all available State and local ources have been used to respond to the situation.
While there are realistic limits to this test, we did find enough examples of

barriers to the effective use of some resources to require that the problem addressed in greater detail. These checks may be proper in normal operations b are not valid in times of crisis. Thus, many of the problems, especially those of legal or procedural nature, could be resolved by exception (e.g., except in cas of disaster the normal rules would apply).

Several illustrations may help to make the situation clear. In one speci case, the Red Cross—at the request of the State—paid the travel expenses of doctor with specialized skills going to a disaster area because there was no w the State could pay or agree to reimburse such expenses, which were incurred a consequence of its request. Secondly, equipment paid for with earmark State or Federal funds sometimes cannot be used on other types of work ev under disaster conditions. Thirdly, the Emergency Services Act restricts the u of State resources for debris clearance (Section 8597a). Fourth, the sar legislation (Section 8623) allows persons qualified in their states—such doctors—to perform in California in a "state of war emergency," but this is n extended to disaster situations proclaimed as a "state of emergency" or "loc emergency." Fifth, it has been reported county equipment sometimes cannot used within city limits because of jurisdictional and liability problems.

Finally, planning might be improved by insuring that all State agenc understand the policy that response to a disaster does not mean "business usual," but becomes a matter of highest priority even if it means increasing th staffs in the disaster area by moving employees from their regular locations a allowing the normal work to pile up. Similarly, through better planning lo governments could make more effective use of people and equipment departments which do not have emergency missions.

We believe that more and better examples could be found, but basically it necessary to expend efforts in advance to identify and solve such problems. T application of resources to disaster problems should not be hampered artificial barriers whose relevance cannot be explained in the midst of a crisis.

*Priority and Implementation.* This is a high-priority item that could implemented through a State seismic safety commission or OES. Costs would low.

## Jurisdictional Roles in Disaster Planning

### 1. Comprehensive Local Emergency Preparedness Plans

By amending the Emergency Services Act the legislature should give t Office of Emergency Services authority to designate and offer incentives those county and city governments and special districts and utilities organi tions that adopt and maintain comprehensive emergency preparedness plans.

*Discussion.* The Emergency Services Act establishes the legal basis f emergency preparedness in California. This act requires a State Emergency Pl and charges the governing body of each political subdivision to take such acti as may be necessary to carry out the provisions thereof (Article 3, Sections 85 and 8569).

However, Article 10 of the act states that counties and cities "may" cre disaster councils by ordinance. Once formed, a disaster council is charged w developing plans for meeting any local emergency; such plans provide for t

fective mobilization of all the resources of the political subdivision, both ublic and private.

Many local jurisdictions view this provision as enabling, but not mandatory. his view is supported by Article 4 of the act, which provides for an Emergency ouncil to advise the Governor; Section 8599(h) states that one of the duties of ie council is to "encourage" the development and maintenance of local nergency plans. Furthermore, OES, which administers the State's interests in ie act for the Governor's Office (Article 5, Section 8586), has no regulatory owers to require county or city emergency plans, nor to prescribe their scope id currency.

To make the existing Emergency Services Act fully consistent, Article 10, ection 8610, should be reworded to clearly obligate counties and cities to repare and maintain emergency plans consistent with criteria established by ES. This obligation should apply as well to special districts and public utilities iat provide essential services such as water, gas, sewage disposal, and electric ower. Thus, the act should be amended to mandate local emergency planning. o this end, OES should seek necessary legislative action.*

*Priority and Implementation.* This is a high-priority measure to be nplemented by the legislature. Costs would be moderate and possibly could be iared by Federal funds.

**2. Areawide Operating Plans and Systems**

The Emergency Services Act should be amended to designate the county overnments to coordinate interjurisdictional emergency operations within the ounty unless, in the determination of OES, a better arrangement is available in ny given area. This will help provide a basis for areawide operating plans and ystems.

*Discussion.* State emergency planning has long recognized the value of itermediate levels of responsibility in the emergency organization to provide for egional and/or areawide planning and coordination of interjurisdictional mergency operations.

The State plan subdivides California into six regions (which recognize county oundaries) to expedite the application of mutual aid between the State and its olitical subdivisions. These regional entities are staffed by personnel from the )ES and representatives of other State agencies.

The California Emergency Services Act, Article 9, provides for additional ower levels or coordination by establishing "operational areas" having boundries coterminous with those of the counties. The governing bodies of the ounty and of each political subdivision within the county may organize and tructure their operational area organizations. The act requires the use of the perational area organizations to work with the State's regional entities in a war mergency, but their use in a peacetime emergency is a local option. The eacetime emergency application of the operational area concept appears valid ut up to now has not been widely implemented in the State.

The State and nearly all of the political subdivisions in the State are ignatories to the California Disaster and Civil Defense Master Mutual Aid

* The report of the Governor's Earthquake Council, dated November 21, 1972, contains a similar recommendation (No. 15a).

Agreement. This agreement provides for mutual aid among the parties, ar requires that "countywide and local mutual aid operational plans be develope by the parties signatory thereto." A very limited number of such plans exis except in the functional areas of fire and law enforcement, wherein positi leadership was provided by OES in response to obvious and freque requirements.

The basis for areawide planning and operations exists in the Master Mutu Aid Agreement and the California Emergency Services Act. However, no specif local jurisdiction is designated to provide leadership and coordinate the planni effort.

Thus, the California Emergency Services Act (Article 9) should be amend to designate the county government (as an administrative extension of the Sta government) to coordinate interjurisdictional emergency operations within t county boundaries unless OES determines a more effective arrangement available. Such operations would occur whenever a city therein or the coun declares a "local emergency," and/or the Governor declares the county or a portion thereof to be in a "state of emergency," or in the event of a "state war emergency," as these terms are currently defined in the act.

*Priority and Implementation.* This is a medium-priority measure to taken by the legislature. Costs are deemed not to be significant.

### 3. National Disaster Preparedness Programming

A national disaster preparedness program should be established that conceptually sound; clearly defines objectives; recommends programs; dete mines the preparedness and response roles of national, State, and loc governments; and includes criteria for performance and the means for evaluation.

*Discussion.* A systematic review and analysis of the concept preparedness for all emergencies, and of the institutional arrangements necessa to accomplish it, appears to be in order for several reasons. First, natural-disast assistance costs have been rising at a rapid rate. Second, knowledge about how reduce hazards and respond effectively to disasters is increasing. In addition, t distinction between war-oriented civil defense programs and measures needed prepare for natural disasters is becoming more ambiguous, and the programs the administering institutions are moving closer together. Also, in nearly eve state and locality emergency preparedness responsibilities are vested in o organization regardless of the cause of the disaster, and these organizations a trying to broaden their roles to more adequately reflect current needs. Finall Federal financial support for traditional civil defense programs has be declining.

Nevertheless, it is a public responsibility to prepare for and be capable coping effectively with the disasters. Many of the preparedness measu involved in civil defense programs, such as emergency operating centers, ha value for any type of crisis. To this is added an increasing uncertainty about t respective roles of the principals involved in disaster preparedness a assistance—Federal, State, and local governments.

The Advisory Group on Disaster Preparedness considered several aspects

problem, each of which may be soluble on the basis of a specific ommendation. However, the approach to this entire subject needs examina-n. For instance, it would have been easy to look at the institutional structure recommend changes, but such changes should be made only after program ctions and responsibilities have been determined.

Therefore, we urge that the current status of preparedness programs be ewed and a national disaster preparedness program be developed that: (1) es national objectives needed to achieve an improved level of preparedness; delineates the preparedness and response roles and responsibilities of the ncipal governmental levels involved; (3) organizes programs that support paredness for all emergencies, and identifies the responsibility for funding h; (4) establishes priorities for preparedness efforts; (5) contains general formance measures for assessing the adequacy of preparedness and progress de toward fulfilling the objectives and priorities; (6) recommends special grams and funding sources to support unique preparedness efforts associated h particular types of emergencies (e.g., financing the securing of radio and ergency-power generating equipment in earthquake hazard areas); and (7) poses changes in institutional structures at all governmental levels that are ded to manage such a program effectively.

*Priority and Implementation.* This is a high-priority recommendation to implemented through an appropriate Federal agency; the costs of this project uld be quite low.

## cial Planning Considerations

### 1. Emergency Action Checklists and Operating Procedures

All departments and agencies that perform emergency public-safety-nted functions within State, county, and municipal jurisdictions should be vided guidance and encouraged to develop and maintain, and be trained to ize, emergency action checklists and standard operating procedures which tain specific ordered actions or activities to be accomplished in the event of a ster.

*Discussion.* Research studies and direct analysis of various disaster rations indicate that emergency action checklists are valuable both for mory-jogging and stabilization, and to ensure that all necessary critical actions l activities are accomplished in accordance with plans and procedures.

Emergency action checklists can be easily devised by competent personnel hin each organization and should list in as concise a manner as possible the ngs the organization must accomplish to safeguard the lives and property igned to it. Checklists, once prepared, should be provided to all persons uired to take any specific actions, and these persons should be instructed in actions to be performed.

The general public (i.e., homeowners and apartment dwellers) should be couraged to prepare such checklists. In many cases the general format and ntent of these lists would revolve on such items as: "stay off the phone—tune portable radio—shut down external gas supply—shut off electricity—cumulate water storage," and so on. Additional protective actions that any

family or individual must take should, of course, also be included.

Every organization typically has procedures that govern the way in whic that organization conducts its operations. Such procedures are used in variou ways: (1) to instruct personnel in proper, acceptable methods of operation; (2 to assure intra-organizational compatibility and standardization; and (3) as planning tool to ensure that all necessary functions are being considered. I disaster preparedness for emergency operations, standard operating procedure provide the basis for appropriate courses of action by the organization. Thes procedures should be oriented, in any given case, around the organization mission and functions, and should serve as guides and training aids for efficien task assignments and for developing a working concept of emergency operation

Because there is no such thing as a standard earthquake, emergenc operating procedures should be representative of the functions to be performe with the obvious reservation that events, as they occur, may modify their use c implementation. Standard operating procedures should not take the place c emergency action checklists.

We recommend, therefore, that OES be provided with the necessar authorities and resources to prepare guidelines and further the development an implementation of emergency action checklists and standard operation proce dures.

This should be accomplished, first, in all State departments and agencie and, through the Defense Civil Preparedness Program, be extended into a counties and city organizations. Industry, through security and plant protectio groups, should be provided with guidance regarding the development and use c such materials. We believe, further, that for this recommendation to be fulfille the State will have to provide the necessary guidance and incentives. It will als have to develop a means for insuring that emergency procedures are up to dat and that the personnel of the organizations concerned know their contents an have the necessary resources for following them.

*Priority and Implementation.* This is a high-priority item and should b implemented through OES. Costs for the additional staff members needed woul be relatively low.

### 2. Emergency Medical Care Planning

A statewide emergency medical care plan that can be made operation at the community level should be developed. The plan should be divided int two parts: (1) a public health section, and (2) a patient care section.

*Discussion.* There is a desperate need for realistic and comprehensiv planning to provide emergency medical care to affected populations in a disaste area. The resources ministering to the casualties must be made available on th basis of total capabilities within the geographic area that could respon effectively (city, county, multi-county region, etc.). This requires any give operational area to be flexible since the boundaries of a disaster are not limite by political jurisdictions. We believe the development of an effective emergenc health system is a shared community responsibility. In such a system emphas should be placed on: (1) immediacy in getting the services to disaster victim

/or the victims to medical or psychological treatment; (2) coordination and
mmunication among the various emergency health services components; and
establishment of authority relationships between governmental, private, and
ntary agencies.

Furthermore, the plan should include, but not be limited to, the following
nponents:

(1) *Emergency Medical Facilities.* There should be a statewide classification
ll facilities according to a recognized classification system such as the one
g developed by the California Medical Association and the California
pital Association. Psychological treatment facilities should be included in the
em.

(2) *Emergency Medical Personnel.* Medical personnel should be available at
determined facilities and/or field locations. They must be adequately trained
their assigned tasks and/or areas of responsibility.

(3) *Emergency Medical Transportation.* Emergency medical transportation
uld include both air and ground vehicles. The personnel of such vehicles must
dequately trained and must know the locations of the emergency treatment
lities.

(4) *Emergency Medical Communications.* Emergency medical communica-
s should be well coordinated in a system linking the various categories of
lical resources (e.g., health facility to health facility, ambulance to
bulance) through a single communications control center of special earth-
ke resistant design.

(5) *Public Information Services.* Public information services should be
gned primarily to inform the general public, but they should also be used to
vide emergency medical services personnel with the information being
eminated to the public. Such information ought to include, but not
essarily be limited to: (a) the designation of primary medical or psychological
lities; (b) when to seek the various kinds of medical treatment available; (c)
rgency public health and patient care instructions and precautions; and (d)
other items of information that may be important or useful in maintaining
health of the population affected by the emergency.

The successful development and operation of any emergency medical
ices plan or system is dependent on many groups and agencies, both private
public, and on their commitment to making it work. Government in general
uld have the primary responsibility for planning, operating, and coordinating
system; it must work closely with organizations from other sectors (e.g.,
dical groups, hospitals, Red Cross). Decisions should be made by both the
vate and governmental sectors in the planning stages as well as during times of
is.

There is no provision for meeting the costs of individual emergency medical
e in a disaster on other than a personal basis. In developing plans, the
tewide medical, dental, and other medical and para-medical associations
uld endeavor to establish emergency medical services groups which will
vide medical services at no charge to patients during a limited emergency care
iod. Supplies and medications should be billed to patients only at cost during

this period. This should be coupled with protection against liability for th participating professionals.

Specifically, OES should be designated as the coordinating agency to assur that an emergency health system is designed. For these tasks, it should have, i an advisory capacity, representation from the private and voluntary service sectors, the State Health Department, and other appropriate government agencies.

*Priority and Implementation.* This recommendation should be given high priority and implemented through OES. It would involve moderate cos for the additional staff required, and support staff should be assigned from th State Health Department.

### 3. School Disaster Plans

The Office of Emergency Services in concert with the State Departmer of Education should require disaster plans of private schools as well as publ schools, and also a better means should be developed for evaluating the qualit of such disaster plans.

*Discussion.* Current legislation requires that each public school have disaster plan and that it revise the plan periodically. This law should be extende to cover private schools also. The school district should have the responsibilit for seeing that this program is carried out for private schools as it now does fo public schools. Presently, plans prepared by each public school are filed with th Superintendent of Schools of the county involved, and the State is notified onl of their existence.

Our examination showed that such plans are not subject to profession review and are revised infrequently. Consequently, among the possible remedi steps, the State might consider action to: (1) schedule the review of plans fo both public and private schools annually by the school district and by count and State emergency organizations every five years; (2) insure that all such plan are forwarded to OES for a cursory review and approval before being filed wit the County Superintendent; (3) develop a program with the State Division o Industrial Safety to check for earthquake resistant mounting and bracing o equipment and machinery in schools; (4) emphasize to teachers the significanc of the school's disaster plan and drills; and (5) train teachers and administrato on procedures for the evacuation of schools and the control and release o students.

*Priority and Implementation.* This is a high-priority item that should l implemented through OES. The costs would be low.

### 4. Access to Damaged Areas

Disaster Plans should incorporate procedures for the identification an control of "official" visitors to earthquake damaged areas.

*Discussion.* Major disasters, especially earthquakes, seem to trigg inspections, investigations, and observations, many by people with legitima professional interests in such problems (e.g., engineers, geologists, researche and foreign government representatives). In the past, problems have be

ountered in authorizing access to damaged areas and facilities, properly ntifying the people involved, and arranging guidance and control mechanisms large visiting groups. Olive View Hospital in San Fernando dealt with this blem for nearly two years, registering thousands of visitors, issuing badges protective hats, conducting tours, and answering questions.

Thus, it appears that the interests of both those conducting investigations the institutions encountering them in the disaster area could be served ctively by establishing "one-stop disaster investigation centers" and associ- l operating procedures in all local disaster plans, perhaps on an areawide s. The major functions of the small administrative office of such a center ld be to issue temporary identification passes that would be recognized ughout the area, obtain clearance for special facilities, provide information, assist in the handling of large groups. To be effective the center would have be staffed by a representative of each jurisdiction and major facility of rest involved in the disaster. It would be necessary, also, for the staff to have authority to issue or deny access without further consultation. Perhaps a le form could be developed listing the particular facilities to which a visitor been authorized access.

Such a program would: (1) reduce the need to develop a single statewide disaster identification system; (2) reduce the uncertainty of local regular and cial public safety officers when confronted by "legitimate" visitors in the d; (3) channel the servicing of such activities away from organizations olved in disaster operations; and (4) enhance the visitor's achievement of his ner own goals.

*Priority and Implementation.* This item has medium priority and should implemented by local governments on the basis of general guidelines issued OES. Costs would be low.

### 5. Safeguards for Occupants of High Rise Buildings

Through legislation uniformly applied throughout the State, imple- nted by the Office of the State Fire Marshal, and enforced by local ernments, it should be required that designs for all buildings over eight ries high include either an acceptable plan for the evacuation of the occupants the creation of internal safe environments. Such design considerations and ns should be included and approved as part of the process of obtaining a lding permit. Such information should be maintained as a public record.

*Discussion.* Increased urbanization has led to the construction of many v high-rise buildings in major cities throughout the State. Approximately 350 such buildings exist in the greater San Francisco Bay Area alone; the Los geles area has at least an equal if not greater number. We have noted that ny of these buildings are apartment houses, which are occupied by large mbers of people for 24 hours a day 7 days a week, and therefore represent a stantial or "high exposure" risk.

These high-rise buildings are of major concern not only because of the mediate problem of structural damage following earthquakes, but also because the consequent probabilities of fire and the associated problems related to the ge concentration of persons in these structures. It is not uncommon to find

such buildings with a capacity for housing up to several thousand people. Fi must often be fought internally because some parts of these tall buildings a beyond the reach of outside emergency equipment.

Elevators in high-rise structures are almost invariably inoperative after a earthquake. Some exit stairways will collapse or be blocked even though th building itself may remain safe. As a consequence, occupants could be trappe or face sufficiently difficult problems of egress to cause panic. With elevato inoperative and stairwells blocked, a fire starting on any floor could pose serious hazard—hundreds or thousands of persons above the fire might b trapped and endangered. If the emergency were to be compounded by rupture water mains within the area or building, fire suppression would be impossible.

A recent study of the situation in the San Francisco Bay Area determine that it would not be unreasonable to expect that out of the 350 existi high-rise buildings 15 to 30 could suffer collapses and another 50 or 100 susta severe damage. Planned considerations and procedures for the evacuation weakened buildings prior to the occurrence of severe aftershocks, or for th creation of safe environments within the buildings, are extremely important the potential saving of lives.

As the pressures of population growth and urbanization accelerate, there w be a corresponding increase in the total number of high-rise buildings. Th problem will not diminish. For this reason—although it might be argued th difficult egress from high-rise buildings is an acceptable risk to the occupants development of evacuation plans, or the institution of design criteria f establishing safe environments in the building, warrants a high priority.

*Priority and Implementation.* This is a high-priority item to implemented by the legislature. An assessment of the costs remains to be mad

### 6. Management of Donated Articles

Disaster plans, particularly at the State level, should include means f controlling the solicitation and donation of articles not needed for disast relief purposes, and procedures for efficiently handling those that do enter t disaster area.

*Discussion.* It is almost axiomatic that in the event of a major and high destructive earthquake in California, two things will occur outside the disast area: first, hundreds of well intentioned groups and individuals will spontaneou ly start commodity drives to which thousands of people will donate food, us clothing, and other miscellaneous items; and second, hundreds of commerc firms will offer to or actually send to the disaster area usable and unusab merchandise, either for good will or for tax write-off purposes.

For example, during Hurricane Camille in 1969, over 3 million pounds canned food plus 2 million pounds of used clothing were forced upon the R Cross. The canned food was in addition to 4 million pounds of governme surplus food made available to the area in standard units suitable for mass feedi or family distribution.

Among the 60 boxcars carrying bulging, broken cardboard boxes of clothi were unmatched shoes (including some with ice skates attached), winter coa ancient and worn lingerie, formal gowns, and so on.

Among the commercial commodities were a semi-trailer load of empty tic bottles with no caps, a load of empty ice cream cartons, 12,000 pounds nsect repellent, and one case of dry shampoo for cats.

The donations, fundamentally unneeded, impeded the movement of essential plies and commercial re-supplies. Volunteer and paid labor was needed to , sort, pack, and dispose of the unneeded items. As was true in this case, sportation costs often far outweigh the benefits.

The problem described arises in every major sensational disaster, and cedures are needed to minimize this difficulty.

*Priority and Implementation.* This is a low-priority item to be imple- ted through the OES. Costs would be low.

**7. Disaster Communications Services**

Each organization having an emergency service function at the State, nty, or municipal level should be required to have a plan for and practice the ctive use of available communications. Such measures should stress maxi- n inter-agency compatibility and information transfer capability.

*Discussion.* Not enough has been done to find out how best to enhance a mmunity's capability for effective communication in an earthquake emer- cy. Analysis of all recent natural disasters, including the San Fernando hquake, has demonstrated that there is no single greater impediment to rdinated emergency operations than the lack of a usable disaster communica- s network which effectively links together, at the proper levels of nization, essential on-the-scene emergency services.

The problem of effective intra- and inter-agency communications occurs ually in the area of multi-service support for fighting wildland fires. It also urs in multi-jurisdictional responses to civil emergencies and other disaster ations. A major earthquake, which would not recognize jurisdictional ndaries and which could cause immediate and oftentimes near-complete uption of normal groundline communications networks, would, perhaps, best strate the need for coordinated communications.

The immediate effects of such an earthquake would require the convergence he stricken area of a variety of emergency-service organizations including se responsible for law enforcement, firefighting, ambulance service, medical , utilities, road repair, and so on. Each of these services in day-to-day ration utilizes assigned radio frequencies on an independent basis. Essen- y, the only monitoring capability that exists resides within a few civil nse emergency operating centers, which may or may not have the capability monitoring all of the essential community communication services.

A careful examination of the single problems of communications in a ster underscores and emphasizes the importance of plans and planning and vious recommendations. There appears to be no one simple solution, and it is arent that any solution may require some modification of present FCC nsing and frequency allocation procedures. Furthermore, no solution which ificantly alters commonly recognized and known procedures and practices— icularly one calling for unusual behavioral responses—is likely to succeed in mergency.

The development of community/area comprehensive disaster communicatio service plans is extremely important, and should not be put off until the "bes solution is found. Enough has been done in certain areas so that some existi model plans could be examined and extrapolated for use in other areas.

The Communications Division of the State Department of General Servic (DGS), should be given the necessary authority and resources to study a determine alternative methods for a long-term solution to this problem, and develop and promulgate model community disaster communications plans concert with OES.

*Priority and Implementation.* This is a high-priority measure to implemented through DGS. Costs for planning would be low.

## STRENGTHENING OPERATING CAPABILITIES

In the immediate sense the effectiveness of a response to a disaster is ated in large part by the availability of resources and the effectiveness of the rating systems needed to analyze the situation, direct and control the onse, and allocate resources for the amelioration of disaster problems. The ctiveness of the response is the test of preparedness, and this group of mmendations is designed to help insure that critical resources and delivery ems are better able to survive damaging earthquakes. Thus, we are concerned with such things as safety of structures housing emergency services, rovements related to the storage and use of resources, the relationship veen an area's configuration and its emergency resources, and related siderations. We also look at the funding of preparedness programs, and ters related to education, information, and training.

### ctures, Supplies, and Equipment

#### 1. Emergency Service Structures and Equipment

The State and local governments should develop standards for earth-ke resistant construction of certain emergency service structures, and ciated non-structural elements, to assure the continuity of vital services owing damaging earthquakes. They should also develop suitable standards ering the design and installation of equipment and furnishings whose nterrupted functioning is essential for the continuity of vital services.

*Discussion.* Recent experience with earthquake damage has demon-ed the need to provide added safeguards for those essential services that e interrupted or suspended because of severe building damage or equipment ure. The development of standards for both the construction and main-nce of essential service structures should have a high priority in any disaster paredness program.

Therefore, emergency service structures, the collapse or damage of which ld preclude or seriously impair services to the public necessary in immediate -disaster earthquake operations, should meet requirements established by Office of Architecture and Construction to insure their ability to continue in ction after a maximum probable earthquake. Such structures include dings housing principal emergency operating centers and governmental mmunications systems, fire stations, police stations, and jails and other ctures housing physically restrained persons.

Suitable standards—such as those developed for schools under the Field —would be required for emergency service structures with provisions for plan cking and construction and maintenance inspections at both the State and l levels.

*Priority and Implementation.* This is a high-priority recommendation to be lemented by the State legislature and by local governments. Costs require her analysis.

### 2. Duplicate Utility System Information

Legislation should be enacted requiring the maintenance of duplica records needed for the continuing operation and repair of vital utility services the event of a disaster.

*Discussion.* The required information should be stored in a separa location from the original documents and in a place secure from possib earthquake damage. It should be updated annually and should include t location and essential details of utility systems including but not necessari limited to the following: (1) sanitary sewers and details of sewage treatme facilities; (2) storm drains; (3) water distribution systems and details of stora and treatment facilities; (4) gas supply systems; (5) electric power distributi systems; and (6) communication systems.

The requirement should be applied to both publicly owned and private owned facilities, but the records could be combined or maintained separate An appropriate State agency should require annual certification from lo public agencies and private utilities of compliance with this requirement.

*Priority and Implementation.* This is a medium-priority item to implemented by the State legislature. The costs would be low.

### 3. Storage of Emergency Supplies

Federal, State, and local agencies that have stockpiled emergen equipment and supplies should insure that these are not stored in hazardo structures.

*Discussion.* Recent reviews have shown that emergency supplies a equipment have sometimes been stored in structures liable to collapse or suf severe damage in an earthquake. Should this occur, the materials would unavailable, and the affected area would be denied critical resources.

The responsible agencies should evaluate current storage locations, m materials out of hazardous structures, and establish procedures to evalu structures in advance of their being used for storage of emergency supplies.

*Priority and Implementation.* This is a medium-priority step to be tak by the Federal, State, and local agencies concerned. The costs would be low.

### 4. Damaged-Building Signs

Localities should insure that supplies of unsafe-building signs prepared and stored before an earthquake; it should be made a misdemeanor remove or alter any such sign when posted.

*Discussion.* Following nearly every damaging earthquake there has bee great and immediate need for unsafe-building signs, and existing supplies h usually been depleted quickly. Also, there are reports indicating that unauth ized signs have been posted by well meaning but incompetent people. On other hand, official signs have been removed or posted inconspicuously a past earthquakes, especially on commercial structures.

Therefore, in the interest of public safety, it seems prudent to have a la stockpile of unsafe-building signs on hand at all times, and stored in sev

tions throughout a city. Where applicable, the signs should be multilingual. al laws should be enacted and quoted on the signs to the effect that it is wful to remove, alter, or relocate such signs, or to post unofficial ones.

*Priority and Implementation.* This is a low-priority measure to be carried by local governments. Costs would be low.

## ning, Education, and Information

### 1. Disaster Information and Data Systems

The State Emergency Plan should include a system for uniformly ering information and statistical data about disasters.

*Discussion.* Because many political subdivisions may be involved in an hquake, there should be a common statistical system which all would use as sis for reports. For example, in the field of medical response and support it ns necessary to know quickly and accurately the number of deaths, the ber of persons hospitalized, and the quantities and locations of surpluses or tages in hospital beds, drugs, and medical personnel. The same type of rmation is necessary in many other fields of emergency response.

If a suitable report form is designed and stocked for ready use, it would litate the uniform gathering of information necessary for operational poses.

*Priority and Implementation.* This is a low-priority item to be imple- ted by the State Office of Emergency Services (OES). Costs would be low.

### 2. Rescue Training Programs

The State, through one of its agencies, should set up an adequate gram to train local public safety and/or public works employees in rgency rescue operations. A sufficient number should thus be trained to ire that a nucleus of trained rescue teams would be available in any hquake disaster.

*Discussion.* The effects of an earthquake disaster generally require that lic employees be capable of performing rescue operations in the efforts to serve life among the victims. An intensive training program integrated with l programs, providing special facilities on a statewide basis and designed to ch the required skills to local public safety and public works employees, uld be beneficial.

Although a great deal of knowledge about the technical aspects of hquakes is not essential in performing vital functions following an hquake disaster, some basic information providing an overview of earth- kes, probable resulting damage, and the effects of aftershocks would most ly allay fears and allow useful functioning on the part of many of the public loyees needed in a disaster situation. An indoctrination program providing h basic information should be required of public safety and public works loyees to better prepare them for their roles in an emergency.

Such training requires adequate facilities difficult to duplicate in many ces, and thus should be set up and operated by an appropriate State agency

for common use. The most appropriate example is the partially federally supported rescue training facility now serving Southern California. The training programs should be run on a continuing basis to provide needed skills throughout the State.

*Priority and Implementation.* This is a medium-priority item which should be implemented through OES. Capital and operating expenses might be high, but they could be offset by Federal help and course fees.

### 3. School Disaster Drills

Legislation should be enacted requiring that fire and earthquake drills be practiced regularly in all elementary, intermediate, and secondary schools in the State.

*Discussion.* Fire and earthquake drills in schools are required by State administrative code, and are supposed to be conducted and checked regularly by local officials. Some schools hold such drills regularly, others intermittently and some do not conduct any. A recent figure presented to us showed that only 58 percent of the public schools hold disaster drills of some kind besides fire drills. It is important, therefore, that local enforcement be strengthened and the requirement for such drills be reinforced through legislation.

Legislation requiring earthquake disaster and fire drills may help protect students in school at the time of an earthquake and subsequent fire, but its greatest benefit would be the learning and practice of personal protective measures that might be of permanent value to the individual.

*Priority and Implementation.* This is a high-priority measure to be enacted by the legislature. The costs, if any, would be low.

### 4. Earthquake Education and Information

A uniform earthquake education program should be developed that would achieve two basic objectives. The first is to inform the public about the nature of earthquakes, about the relatively simple and inexpensive precautions that can be taken before an earthquake to minimize individual injury and property damage, and about the kind of behavior during and immediately after an earthquake that would further lessen injuries. The second objective is to advance the public's understanding of the need for State seismic safety programs.

*Discussion.* There is a need to improve the understanding of the State's residents about earthquakes and other natural hazards to which they are exposed. There is also a need to emphasize the availability to the individual of measures for minimizing the impact of and responding appropriately to disaster. The dividends of earthquake education programs will be the saving of lives and the reduction of injuries and property loss in case of damaging earthquake. While major concerns, such as geographic location and structural adequacy cannot be realistically or economically faced by the individual, some simple steps (e.g., stocking minimal emergency supplies, identification of safe areas in buildings at home and at work, knowledge of post-earthquake precautions such as shutting off gas and electricity, and others) can be undertaken with little time and money.

A properly conceived educational program could also point out the ficiencies of a coordinated statewide approach to developing programs and dministrative procedures which local authorities can then build upon in their ective areas. The educational system can be used more effectively to achieve e purposes by teaching the future adult and providing a means of mmunicating information to his or her parents.

Specifically, we recommend the following actions be taken:

(1) The legislature should require that an earthquake hazards program be included in State required curricula, perhaps as part of a safety education course. Some schools are doing this voluntarily and their example may prove useful.

(2) Teaching aids, such as pamphlets, films, slides, and specifically trained speakers should be used to better advantage, or developed where needed to help insure an acceptable quality of instruction.

(3) Instructional posters should be posted in schools, and materials should be distributed for use at home.

(4) An in-service course on natural hazards should be established, and similar course work should be required for teaching credentials.

*Priority and Implementation.* This is a medium-priority program which uld be implemented by the legislature and the State Department of cation with assistance from OES. Initial costs would be the highest, and to effective the program would have to be maintained. Thus, annual operating s would be low, but would constitute a significant long-term investment.

## ancial and Administrative Measures

### 1. Emergency Funding

Annual appropriations for emergency and disaster assistance activities uld be greatly increased; the role of the State Office of Emergency Services in inistering the funds should be strengthened; and the funds should be made ilable to local jurisdictions for disaster assistance purposes.

*Discussion.* We have found that the $1 million appropriated annually for rgency activities is exceeded regularly and is an unrealistic minimum. The of the funds is determined by the State Department of Finance, although S is responsible for disaster activities in the State and is the principal agent of Federal Government in administering disaster relief funds. Furthermore, the of State emergency funds is limited to the reimbursement of State agencies. st, if not all, local governments cannot afford to have a special emergency d, and some necessary actions in times of disaster are often delayed because financial support is available.

In our opinion the annual appropriation to the State's emergency fund uld be raised to $5 million and maintained at this level. Moreover, a program better coordinate the distribution of State and Federal funds should be cted by the legislature. The concept of a State "Natural Disaster Assistance ," such as presented in AB 24 (1971), should be considered. As a minimum it uld provide that OES be the principal administering agency for emergency ds and for development of standard procedures for their use. Also, such a

program should provide reimbursement to local governments for unusual cos associated with disasters. The authority given to OES should clearly indicate th in times of disaster the agency's director can obligate the State's emergen funds without further question and regardless of whether or not such cos might be reimbursed by the Federal Government. This would go a long wa toward improving local governments' immediate response to disasters.

*Priority and Implementation.* These steps should receive a high priori for implementation by the legislature. The addition of $4 million does n constitute a substantial budget increase and recognizes the well documented fa that annual costs related to emergency activities actually are at about this lev

**2. Disaster Services and Benefits Analysis**

The legislature should require the preparation and distribution of summary information chart indicating all services available in connection wi disasters and appropriate procedures for obtaining them. The requirement mu also call for the regular review and updating of the document, which should disseminated widely to concerned public and private organizations throughc the State.

*Discussion.* One of the most common problems associated wi preparation, operations, and follow-up activity in major disasters is that faced agency and jurisdictional officials in sorting out the many possible emergen and support services that may be available through mutual aid and oth programs from public and private sources. Information about these is scatter among thousands of pages in hundreds of documents from scores of sourc There are probably few people, maybe none, who have a comprehensi overview of the many available services which might be relevant to disas situations. This recommendation is posited with the suspicion that it would n be possible for any one person or staff to assemble in a useful format t complete relevant data. The effort to do so, however, is seen as having the advantages:

(1) It could, as an initial effort, constitute a valuable statement of t problem and an overview of the areas where substantial jurisdictional or agen overlaps occur, where there are contradictory requirements and services, a where open competition exists among various governmental levels and pub and private services. The net result of an overview of these elements might ass in rationalizing the overall efforts and allocating functions and programs or more systematic basis.

(2) Even an incomplete summary could be extremely valuable as a han reference source and as a training aid. In order to be useful it must be present in a simplified format, probably graphic, which would include all of the k elements and their interconnections, and provide a conceptual framework the philosophy of services and operations envisioned.

Clearly it would have little value after a few months if not updated o regular basis.

*Priority and Implementation.* This is a medium-priority measure to implemented by OES with the assistance of the major organizations involv

al preparation of the document would take the greatest share of the total but this would not be prohibitive, and the maintenance cost could be rporated into the regular plan maintenance process.

**3. Disaster Assistance Eligibility, Operating Policies, and Benefits**

The appropriate Federal agencies should examine and modify as ssary their disaster assistance programs—particularly as they relate to viduals—from the viewpoints of equitability, consistency, and operations.

*Discussion.* An existing requirement for a Presidential declaration of a jor disaster" in California is the incurring of disaster related expenses by the e and its political subdivisions amounting to at least $5 million in the eding twelve months. The requirement in Nevada, a less populated state, is $350,000.

A small earthquake occurring in Nevada might be declared a major disaster, ving victims the benefit of Small Business Administration loans with veness features under provisions of Public Law 91-606 and other assistance rams. Yet an earthquake of the same magnitude, and affecting the same ber of people, could occur in California, and if the State had not previously t the specified minimum number of dollars for disaster activities, a "major ster" declaration might not be recommended and the victims would be ed the same benefits accorded the Nevada residents.

Consistent policies in providing equal benefits ought to be followed when a eral agency delegates to a state or political subdivision the operation of an tance program during a major disaster.

For example, in a Presidentially declared major disaster, the President may orize the distribution of food coupons through the U.S. Department of culture to low income households under such terms and conditions as he prescribe. The authority is contained in Public Law 91-606.

Thus far, management of the food stamp program in disasters has been gated by the Department of Agriculture to the affected state, and legated by the state to the affected counties where it has been conducted by counties' social services departments. With different counties involved at erent times, the extension of benefits has varied from liberal to restrictive.

A major earthquake in some California locations would undoubtedly affect a ber of counties simultaneously. In this circumstance, equality in the ibution of benefits must be observed. As a minimum, for instance, qualified esentatives of the U.S. Department of Agriculture should be continually gned to field locations in disasters to supervise the food stamp program.

In addition, all local disaster plans should include provisions for assisting e and Federal agencies in establishing and operating disaster assistance ers to meet the needs of disaster victims.

Moreover, the Farmers Home Administration (FHA) should adopt policies disaster loans to individuals similar to those of the Small Business inistration (SBA).

Currently, the FHA disaster loans do not include provisions for covering s of household furnishings other than kitchen or laundry appliances. versely, SBA loans may cover all household furnishing losses including hen and laundry appliances.

This variance creates an inequality between farmers and non-farmers. major earthquake will likely affect the homes of farmers as well as urb dwellers, and the overwhelming task of trying to effectively administer bo types of loans and determine eligibility will simply retard an expeditio recovery loan system.

*Priority and Implementation.* This is a medium-priority recommendati to be implemented by the appropriate Federal agencies. Costs do not see significant.

### 4. Contingency Staffing

Cities and counties in California should be encouraged to develop spec staffs (appropriate to their size and complexity) with functional responsibili for developing information and plans for all types of major contingencies (n only disasters) which might conceivably affect the jurisdiction.

*Discussion.* A principal characteristic of organizations is the propensit to develop highly articulated subsystems to handle routine operations. Depar ments with administrative procedures are established for all activities which a seen as relevant to the interests of the organization and are projected over a extended period of time. A main reason for the success of the bureaucrat approach to organizational design is its effectiveness in carrying out compl activities which are capable of being predicted and routinized. Corollary to th advantage is the disadvantage entailed when dealing with problems which occ only infrequently and/or with low predictability. Organizations usually alloca responsibility for handling new and/or unpredicted problems by means of high random task assignments to the established subsystems that appear to ha similar areas of responsibility or jurisdictional interests. One of the consequenc of this practice is a relatively low efficiency in dealing with major events whi occur with little warning, are not foreseen, and require the coordination of tw or more subgroup activities—as in the case of an earthquake, for example.

One of the problems with present staffing patterns for disaster services that, since major events occur so infrequently (in many jurisdictions neve most of the time of the specialized staff is spent planning for specific events th may not occur. The same city or county will, during any given year, probab experience a number of major unexpected events of one kind or anoth affecting its organization. A special staff, integrated into the top executive lev should be designed to be alert to short- and long-range developments in t operating environment. In advance, it could discuss and explore tentative pla and responses for virtually every kind of contingency which might have impa on the community.

Rather than prepare for a few specific kinds of disasters, such as floods, rio earthquakes, or nuclear attack, the jurisdiction might be better served if enlarges the function of contingency planning to include *any type of maj change* in the environment which might seriously affect the community government. This implies that to the extent the service becomes specialized a routinized to cover a wide range of potentially uncertain events, organization capabilities will be enhanced and, therefore, benefit the community.

The recommendation should not be construed to suggest reduction

ination of present central disaster service staffs. Rather it posits that they be even more effective when included in a broader functional role of tinuing value to the organization. This might include not only planning the onse to an earthquake but to any kind of major event such as an unexpected or change in funding, which can better be dealt with through a planned, rdinated approach.

*Priority and Implementation.* This is a medium-priority item to be lemented by the organizational entity concerned (i.e., city or county rnment, State agency, private organization). Costs might be offset by the ocation of, or slight increase in, the staff.

## EVALUATING PERFORMANCE

One of the greatest problems in preparing to cope with disasters lies in r knowing beforehand to what extent the steps and actions planned will succe in providing the desired results. Hence, the recommendations in this section a concerned mainly with developing and using the best possible techniques assessing the effectiveness of disaster plans and operations.

### 1. Preparedness Performance Evaluations

Active programs should be established for the development, testing, a validation of comprehensive predictive criteria relevant to assessing disas preparedness efforts.

*Discussion.* Along with the problem of the unpredictability of disas events and the question of cost-benefit ratios for elaborate preparedn measures, is the difficulty of not knowing in advance (and even afterwar whether given response activities are the best or most appropriate for any giv disaster situations. We will probably never be able to reach sufficient control as to be able to reduce risk to near zero, but we can move closer to controlli the events connected with major disasters, such as earthquakes, so as to redu the loss of life and property and interference with the regular processes of c society.

At the present time we have only very crude means of determining the le of preparedness necessary to deal with a variety of potential contingencies. T best model available seems to be that developed by the fire rating bureaus. could be appropriate to draw on and extend that model so that it covers r only fire and associated events, but the entire spectrum of predicta contingencies with respect to a given jurisdiction.

In fact it is safe to say that at the present time the state-of-the-art complex-performance evaluation would not permit the construction of a rea high-predictability model. However, it should be quite feasible to impro present approaches. Besides exploring the value of broadening the scope of fire rating system, there is the possibility of integrating performance and otl preparedness criteria into the relatively sophisticated nationwide system alrea operated by the Defense Civil Preparedness Agency and several resea organizations. These rating systems and similar ones are relatively clumsy a based on counting items. While certainly better than nothing, they still give indication of how the systems work together under stress. Some experimen evaluation programs are currently being conducted to develop criteria for measurement of organizational performance. The progress to date indicates need for much more work and experimentation in this area.

One advantage which would result from designing and applying performa criteria to training and exercising circumstances is an enhanced ability to pred the likely performance of organizations in a variety of potential major disast

*Priority and Implementation.* This is a medium-priority proposal efforts by State and Federal governments, universities, and research organi tions, in conjunction with professional associations. The costs are difficult determine, but a modest amount for research should be made available.

**2. Review of Local Emergency Plans**

A formal process should be established by the State Office of Emergency vice to provide for the review and approval of local emergency plans.

*Discussion.* The following are relevant excerpts from the California ergency Services Act. Section 8569 states in part, "The Governor shall rdinate the preparation of plans and programs for the mitigation of the cts of an emergency by the political subdivisions of this state, such plans and grams to be integrated into and coordinated with the State Emergency n and the plans of the federal government and of other states to the fullest sible extent." Section 8570 states in part, "The Governor may provide for approval of local plans."

Section 8586: "The Governor shall assign all or part of his powers and duties er this chapter to the Office of Emergency Services."

The Office of Emergency Services (OES) now serves as the administrative ncy for the Governor's Office in the review and approval of local emergency ns. OES has an organizational element which provides local planning guidance which reviews and approves submitted local plans. The problem rests with icle 10, Section 8610, of the act, which does not mandate the preparation of l emergency plans. Since local plans are not required by the Emergency vices Act, the OES review and approval process is accomplished primarily to sfy the requirements of the Federal Defense Civil Preparedness Agency PA) relating to its contributions programs in which all of the counties and roximately half of the cities are currently participating.

In the past, DCPA programs have been largely war-oriented, and local plans the most part reflected that emphasis. A recent broadening of interest to ude natural disasters should improve the local planning base.

To be effective, review and approval of local emergency plans must be based part upon a requirement to prepare and submit such plans (see recommenda- n 2 under "Planning for Disasters"). OES seems to be the logical agency to duct this process. However, additional staff members will be needed by that ncy to accomplish this task in a comprehensive and timely manner.

*Priority and Implementation.* This is a medium-priority recommendation ch should be implemented through OES. Costs would involve the addition of f members to operate this program properly.

**3. Testing and Exercising Disaster Plans**

The cities, counties, and State and Federal agencies in California, as well he larger private organizations (e.g., universities, hospitals, businesses) should ncouraged to conduct organization-wide disaster exercises at least annually.

*Discussion.* An important gap exists between the completion of plans policies concerning disaster activities and operations, and the actual ration of complex social systems during major disaster events. The best ns for reducing this gap is by the systematic use of disaster simulation cises. The exercises must be followed by comprehensive critiques and ews of the plans, procedures, and resources required to operate in the face of or disasters. Particularly important at jurisdictional and major agency levels is

the development of a central emergency operations center staff able coordinate, direct, and integrate operations and information for a jurisdictior and/or geographical area.

Long-range experience in the development of effective response tear indicates that the best means for achieving this end is through system exercis conducted at least annually over a period of several years. An effective model f the design and conduct of such exercises has been developed by the Defen Civil Preparedness Agency and fielded nationwide through the Civil Defen University Extension Programs in each state. Indications, from more than 1( exercises in this program conducted in California during the past four yea under the auspices of OES, are that many significant planning and operation problems will be brought to light through the use of a continuing exercise a critique program.

Some key assumptions entailed in carrying out such a program are follows:

(1) Next to an actual major disaster, a simulated exercise provides t most effective and efficient means of learning about weaknesses emergency operations plans, procedures, and resource systems.

(2) In day-to-day operations most people in a given jurisdiction agency do not have occasion to integrate their services very closely. Maki the necessary decisions for effective emergency operations requires th officials work together as well as possible. Exercises provide opportuniti for the officials involved to get to know each other and to jointly work o some of the common problems they might face in a major disaster.

(3) One of the main problems with comprehensive plans is the tenden for some sections to become obsolete. Since the environment, resources, a people are constantly changing, plans need to be reviewed actively at lea annually in order to remain current. The best way to do this is throu system exercises with provision for updating plans and procedures. Disast exercises ought to be an integral part of most of the other short- a long-term planning and preparedness activities.

Each city, county, Federal and State agency, and major private organizati must assume responsibility for its own preparedness. OES seems to be the mo appropriate agency to develop and coordinate such programs, receive repor and summarize information for formal exercise activities throughout the Stat

*Priority and Implementation.* This is a high-priority recommendation be implemented by the organizations and jurisdictions involved. The costs each would be relatively low if the existing program is used to advantage.

### 4. Evaluating Disaster Operations

The State Office of Emergency Services should be assigned respon bility for seeing that systematic professional analysis and evaluation of disast operations and recovery activities are carried out on-site during and immediate subsequent to a major disaster.

*Discussion.* A review of disaster studies indicates a consistent absence of a comprehensive analysis of the actual operations of the working groups within jurisdictions and multi-jurisdictional entities during and subsequent to major disaster events. Much of what is available along these lines is subjective, highly biased, and anecdotal, or consists of documentary evidence of communications, written orders, reports, and the like, on a fragmented and piecemeal basis. Although some systematic work has been done, there is at present no conceptual framework for approaching systematic analysis of how organizations actually operate during disasters and immediately afterwards.

In order to discover whether there might not be some valuable generalizations which could be developed through analysis of decision-making, resource allocations, and field operations during major disaster events in California cities and counties and other large organizations, it will be necessary to designate teams of specialists to carry out professional observations and develop more comprehensive systems for analysis of disaster response activities. Such information should provide valuable assistance in developing better plans and models for jurisdictional disaster response programs for different contingencies. Also, it should serve to clarify significant weaknesses in the planning and implementation of disaster response programs, as well as critical problems related to preventive measures.

Methodologies for economically and efficiently collecting complex organizational performance data are not well developed. The task is further complicated by the political and social aspects of disaster operations analysis. The need to cover mistakes made and protect the reputation of the organization from public attack is important, quite apart from problems caused by serious differences of opinion about what were right or wrong actions.

Clearly lacking at the present time is an adequate incentive for city and county governments to develop their own means for comprehensive (multi-departmental) analysis of major disaster responses. We believe that it is appropriate to require jurisdictions receiving disaster planning funds to conduct professional analysis and assessment of their operations in response to actual disasters, and to develop specific ameliorative actions to be taken as a legitimate quid pro quo for the moneys they receive to help reduce recurrence of the same problems in future disasters.

*Priority and Implementation.* This is a high-priority measure to be put into effect by the State Office of Emergency Services and carried out by organizations deemed qualified and suitable for this activity. This would be a low-cost continuing program that would have a long-term reward.

## MINIMIZING FUTURE DISASTER PROBLEMS

These recommendations, made from the standpoint of disaster preparedne deal with a variety of measures to minimize or eliminate hazardous conditio The existence of such conditions, exemplified by thousands of non-earthqual resistant buildings, can be the cause of major problems in responding to disaste Several of these proposals are also dealt with by other groups, but our inte here is to reinforce their concern. Topics in this group include the abatement hazardous buildings, public safety systems related to planned unit developmen improving existing codes, problems with the repair of substandard structures, a the like.

### 1. Improvement of Existing Codes

Legislative action should be taken to institute a program for developi major revisions to existing building and safety codes as a means of improvi design provisions for seismic safety.

*Discussion.* The San Fernando earthquake of February, 1971, provide significant evidence of extensive deficiencies in existing codes and the need f their improvement. Analysis of recent earthquakes has furnished sufficient ne information to dictate immediate modification of building and safety standar in an effort to incorporate additional seismic considerations in the design an construction of new buildings. Measures in related areas within the realm preparedness which need extensive improvement include:

(1) Regulation of design and anchorage of non-structural building iten such as exterior architectural materials and veneers, pre-cast panels, elevat equipment, light fixtures, mechanical equipment, ceiling systems, electr power equipment, non-bearing partitions, interior finish materials, an glazing, as well as shelving, cabinets, racks, and containers related to stora facilities;

(2) Augmentation of lateral (seismic) design forces and provision f vertical acceleration design forces;

(3) Consideration of the influence of the type and depth of soils at th building site on the dynamic behavior of building structures;

(4) Development of seismic design criteria for structural connectio details, building joints, and prefabricated building systems interfaces;

(5) Codification of stricter requirements to insure the unimpaire functioning and structural integrity of emergency exits and stairways;

(6) Enactment of special code requirements to deal with highe standards for emergency service facilities such as hospitals, communicatio systems, city halls, fire stations, and others.

Code revisions are directly related to the reduction in numbers of potenti casualties. The 1933 Field Act which governs school design in California is cite as setting a successful precedent for effectiveness in code revisions related t disaster preparedness.

The program should be applied on a uniform statewide basis and under th jurisdiction of California code agencies or other appropriate regulatory bodie

revisions recommended by this program should be incorporated in the ective building and safety codes governing design and construction, and anded to include all equipment and furnishings considered part of a properly ctioning building and/or affecting the health and safety of its occupants.

*Priority and Implementation.* This is a high-priority item to be lemented by the legislature, with assignment of duties to a State seismic ty commission or appropriate State agency. Costs for the code revision gram would be relatively low, but the impact on construction costs might be ificant.

**2. Enforcement of Existing Measures**

Techniques and measures should be developed to improve the enforcent and application of existing laws, ordinances, and regulations related to mic safety.

*Discussion.* We have become aware of several examples of laws, inances, procedures, and other measures related to seismic safety that are not ng administered adequately. Unfortunately, any expressions of public ncern will have little effect on safety if they are not linked to viable programs. r example, the City of San Francisco has a parapet ordinance on its books, its enforcement seems ineffective.

We are unsure to what degree this represents a widespread problem, but it uld seem proper that, as a minimum, an assessment should be made of the orcement status for existing measures. Methods should then be developed to her apply the statutes more effectively or take them off the books.

*Priority and Implementation.* This is a medium-priority item to be plemented through a State seismic safety commission or other appropriate te agency. Costs should not be excessive since adoption of these measures ginally must have been based on a funding commitment, and the only thing ed is that the commitment be lived up to.

**3. Hazardous-Building Abatement**

The legislature should require all local jurisdictions to establish a gram for the orderly repair, reconstruction, replacement, or demolition of all sting earthquake-hazardous structures occupied by humans in California signed and built before the adoption of the Riley Act (Chapter 601, Statute 33), except for those structures specifically excluded by the act.

*Discussion.* By a legislative act (Chapter 601, Statute 1933), the lifornia Legislature at the 1933 General Session established minimum ndards for the design and construction of all buildings in the State with pect to lateral-force resistance. This legislation is commonly known as the ley Act.

The act required all local jurisdictions to enforce the specific requirement at all buildings be designed to resist lateral forces. Exempt from the act were m buildings and dwellings planned for not more than two families, outside the its of an incorporated area.

The act did not require that existing buildings incorporate these standards. was intended by the legislature that in the intervening years, continuous progr be made in the repair, reconstruction, or replacement of structures built prior the enactment of the legislation.

Forty years have passed since the enactment of the Riley Act. It should the intent of the legislature to reexamine the progress under this article. enable it to do so, and to expedite the provisions of safer facilities for t general public, the legislature should require all local jurisdictions to establis program for the orderly repair, reconstruction, replacement, or demolition of earthquake-hazardous structures in the State designed and constructed befc the adoption of the Riley Act.

The Department of Building and Safety of every local jurisdiction, or if jurisdiction does not have such a department, a registered structural engine civil engineer, or licensed architect, appointed or retained by the governing bo of the jurisdiction, should investigate all buildings with the exception of or and two-family residence and farm buildings, which were not designed a constructed in accordance with the lateral-force requirements of the Riley A The examination of all such buildings should be completed by a specified da The examining official, a registered structural engineer, civil engineer, or licens architect, should recommend to the governing body of the jurisdiction wheth or not the structure is a potential earthquake hazard.

It should be required that the structures deemed hazardous be repaired reconstructed by a specified date, to conform to the lateral force requiremer of the latest edition of the Uniform Building Code, Zone 3, or be demolished.

A registered structural engineer, civil engineer, or licensed architec employed or retained by the governing body of any jurisdiction to examine a building should not be held personally liable for injury to persons or damage property, as a result of the structural inadequacy and failure of a buildin provided he has exercised normal professional diligence in carrying out h functions as provided in this legislation. In any program, importance facto relating to occupancy should be considered.

A number of professional organizations have endorsed the need to undertal a hazardous-building abatement program.*

*Priority and Implementation.* This is a high-priority measure to b implemented by the legislature. The proposed program would have a substanti economic impact throughout the State.

### 4. Protection of Lifeline Systems

A program should be established to insure that adequate standards a developed for future, and a review made of existing, utility, communication and similar lifeline systems, from the viewpoint of seismic-resistant design.

*Discussion.* Pipelines and other underground conduits are among th lifelines by which cities meet their needs for energy supply, water supply, wast

* These include the Structural Engineers Association of California, the America Society of Civil Engineers, the Earthquake Engineering Research Institute, an the Southern California Chapter of the American Institute of Architects.

posal, and communication. All of them, by the very nature of the event, are ne to failure in an earthquake, and their failure creates serious problems for people in the stricken area. This state of affairs is attributed principally to o factors: (1) the comparatively low state-of-the-art of lifeline earthquake gineering, as compared to building earthquake engineering; and (2) the many es for selecting underground conduit material and designing its installation, er than resistance to earthquake forces.

Recommendations previously submitted in a report to the Joint Committee Seismic Safety and its Subcommittee on the San Fernando Earthquake are ieved to constitute the most hopeful approach to the problems.* These ommendations stress a professional approach to the lifeline earthquake zard problem and an expanded study and research program which could be mulated by Joint Committee action along the lines proposed in the ke-Moran report.

We recommend that further study and research be given to lifeline problems h as (1) fuel and oil lines crossing active faults, and (2) flexible pipe nnections used in power and pumping plant installations.

*Priority and Implementation.* This is a high-priority recommendation, d we believe that a State seismic safety commission or appropriate State ncy should foster and monitor the progress of a program such as the one posed. The cost of program design would be relatively low, and an assessment its full impact would have to be developed.

### 5. Planned Unit Developments

Minimum State requirements should be established and enforced locally insure that small privately owned utility distribution systems, such as are stalled in planned unit developments, are properly designed, managed, and intained.

*Discussion.* Accompanying the recent rise in popularity of "open-space" "cluster" type residential developments with their innovations in site planning ve been proposals for changing the traditional methods of providing gas, ctricity, water, and sanitary and storm sewer services, and the maintenance of cess and circulation facilities. All of these facilities are usually owned in mmon by all of the homeowners in the development and maintained by an sociation to which all the owners must belong.

Since private maintenance of any portion of the utility system would be a parture from conventional requirements that were designed to guarantee rtain levels of service and health protection, deviation from them should not cur unless the government determines either that these levels will be met lequately by other means (such as through the homeowners association) or at the levels may safely be reduced.

The government would appear to have at least four basic concerns in its role regulating new development which could be used as guides in evaluating ternatives for providing and maintaining utilities. They are:

*See C. Martin Duke and Donald F. Moran, *Earthquakes and City Lifelines*, February, 1972

(1) Its obligation to prohibit the creation of any development that likely to pose present or future threats to public health and safety, includi seismic safety

(2) That design and improvement standards in new subdivisions provi not only adequate initial service, but will also protect the community fro unanticipated future expenses

(3) Protection of the home buyer who believes that having boug property in a county-regulated-and-recorded subdivision, his utility servic will be relatively problem free, or that if problems develop, loc governmental agencies will respond quickly to correct them

(4) That in the interest of governmental economy, efficiency, a responsiveness, proliferation of districts and quasi-districts, and the ov lapping or duplication of district functions be avoided.

These concerns with respect to provision of utilities have in the past be satisfied in residential subdivisions by having utility services to each individu lot be designed, inspected, owned, and maintained by public utilities subject regulation by the State Public Utilities Commission or by public agencies havi taxing powers. Assured, thus, are the means for providing quality service on permanent basis because of the inherent financial resources available and t control to which these public bodies are subject from the community.

By contrast, the homeowners association does not appear as satisfactory vehicle for providing these services, and would in most cases duplicate or overl functions capable of being performed by established bodies. The homeowne association does not have the power to tax, it is not subject to significant contr by the larger community, and is unlikely to have the equipment, expertise, a financial capability to perform as well as the established public agencies.

As an element of the planned-district concept, the homeowners associatio was created to maintain the common areas, and to this extent can be expecte to function properly. It has the power to levy periodic and special assessmen upon its members and to build up reserve funds for contingencies; but since it also directly responsible to its membership, its financial capabilities—and there the level of maintenance it provides—will tend to be limited to what t homeowners association members are willing to pay. Burdening the homeowne association with too many responsibilities could cause its collapse (particular in lower-cost developments), avoidance of some of its less critical respons bilities, such as landscape maintenance, or its insistence that the county tak over its responsibilities.

Most knowledgeable persons seem to share more or less the same attitud toward planned unit developments that the water purveyors should maintain t lines and install the meters at or close to the dwelling units. This conforms wit the policy recommended for utilities in such developments by the Alame County Planning Department. The reasons for this attitude are mainly: concer over the maintenance of the pipe system, doubts about whether sanitatio standards are met, and doubts about the maintenance of adequate records for us in emergencies.

*Priority and Implementation.* We consider this recommendation to have igh priority; the legislature should set minimum requirements for local orcement of the provisions. Without further study, the costs implications are ficult to evaluate.

### 6. Public Safety Resources and Urban Design

A program should be established to develop minimum standards for ious kinds of public safety services to help insure that every city, county, cial district, and other jurisdiction responsible for safety services in the State adequate resources to meet its basic emergency needs.

*Discussion.* We have discussed several examples of communities that have invested adequately in basic emergency resources that would insure a imum capability to meet the needs of the given community as it exists lay. Moreover, agencies with adequate resources are called upon too quently to assist those who do not maintain a proper minimum service level. is dependency should not be encouraged.

For example, many industries that employ hazardous processes locate their nts in small communities so as to be close to a supply of raw materials or ap power, or for some other similar reason. Planned unit developments ploying unconventional design concepts, occasional high-rise structures, and er such problematic features often come into being in communities that do have "standard" public protection facilities. Likewise, public events such as ock" festivals cause large numbers of people to congregate in temporary ations where law enforcement, health, transportation, and other facilities are equipped and staffed to meet the needs presented. Real estate subdivision ivity often results in the population of areas that are difficult to protect—with tricted access, no escape routes, or other emergency-service hindrances.

Minimum standards will have to be established for levels of service to be vided by the various kinds of services. An example of such standard-setting ght be the fire-insurance industry's approach to grading municipal fire enses. The necessary standards should be developed by voluntary profes- nal, vocational, and functional organizations, such as the American Public rks Association, American Water Works Association, International Associa- n of Fire Chiefs, and International Association of Chiefs of Police, among ers. Wherever the minimum standards are not maintained, the jurisdictions olved could be penalized by higher insurance premiums and other such asures.

In addition, State legislation related to building standards, property velopment standards, and public safety standards should establish minimum uirements and should encourage local jurisdictions to be more restrictive than the basic State standards. The recent trend towards setting State-mandated ximum standards for code adoption and enforcement should be reversed by legislature.

*Priority and Implementation.* This is a high-priority item; the legislature uld authorize a special study of the problem and its cost implications before ceeding.

### 7. Review of Occupancy Certifications

A program based on minimum State standards should be established t provide for a periodic review by local governments of the occupancy c structures; periodic occupancy reviews should be closely coordinated with a active hazardous-building abatement program.

*Discussion.* The codes or ordinances of all jurisdictions throughout tl State have sections relating to the occupancy of buildings. These sectio generally require that a "certificate of occupancy" be issued and posted for a occupancy other than single-family residences and structures accessory theret Changes in the character or use of a building are prohibited unless the structu is made to comply with the requirements of the code. Exceptions may b permitted only if the new or proposed use is less hazardous than the existing us Assurance of compliance with recommended standards can be secured only by continuing inspection program to ensure that occupancies are not chang without proper review. Moreover, the program should limit the time a certifica of occupancy is valid so that periodic recertification would be required a could be based partly on reinspection of the structure to assure a continui minimum level of safety.

*Priority and Implementation.* This is a high-priority measure whic should be implemented through a State seismic safety commission or oth appropriate State agency. This could be a low cost activity integrated in regular building inspection programs.

### 8. Earthquake Standards for Private-School, State-College, and Stat University Buildings

The provisions of the Field Act should be expanded to include priva school buildings and State college and university buildings, and a requireme for conformation or abandonment by a specific date should be included.

*Discussion.* The Education Code of the State of California includes requirement that all public school buildings be brought into conformance wit the provisions of the Field Act or be vacated by 1975. Existing private scho buildings and State college and university buildings should be subject to th same requirements as public school buildings under the provisions of the Fie Act. For this reason it is recommended that the Field Act be expanded to appl to private school buildings and State college and university buildings wit enforcement of the requirements delegated to the local jurisdictions. Howeve in cases where the local jurisdiction does not properly enforce such regulatio for these school buildings, the State Office of Architecture and Constructic should be assigned the task of enforcing such regulations as it does now f public schools.

*Priority and Implementation.* This is a medium-priority measure to b implemented by the legislature. On new construction the costs would be mino but if existing structures were required to conform, the impact on private scho and State college and university school financial resources could be significan

# Report of the Advisory Group on Postearthquake Recovery and Redevelopment

## ADVISORY GROUP ON POSTEARTHQUAKE RECOVERY AND REDEVELOPMENT

Angelo Adams
Regional Vice President
Union Bank
1970 - 1972*

Robert P. Biller
Professor of Public Affairs
University of California
1970 - 1971

Charles Bundschu
Assistant Manager, Pacific Division
Hartford Insurance Group
1970-1974

Geoffrey Commons
Northrup Airport Development Corporation
1971 - 1974

Arthur E. Dreyer, *Vice Chairman*
Asst. Chief, Div. of Codes and Standards
State Dept. of Housing and Community Devel.
1970 - 1974

Charles Ford
Firemans Fund Insurance
1970

Louis J. Fourcroy
Department of Public Works
City of Palo Alto
1970 - 1974

Jack Green
City Councilman
City of Huntington Beach
1970-1972

Ken Hoagland
City Attorney
City of Bakersfield
1970 - 1972

Roy Hoover
Director, Department of Urban Affairs
County of Los Angeles
1972 - 1974

Wilbur Lage
Coordinator of Civil Defense
City of Huntington Beach
1972 - 1974

Henry M. Layne
Consulting Structural Engineer
Henry M. Layne Inc. & Associates
1970 - 1974

Frank E. McClure, *Vice Chairman*
Consulting Structural Engineer
McClure & Messinger
1970 - 1974

Richard G. Mitchell
Admin., Community Redevelopment A
City of Los Angeles
1970 - 1974

Will H. Perry, Jr., *Chairman*
Director, Office of Emergency Services
County of Contra Costa
1970 - 1974

E. Jack Schoop
Chief Planner
S.F. Bay Conservation and Developmer
1970 - 1971

Ronald Swenson
President
Swenson Building Technology
1970 - 1972

Frank C. Treseder
Architect
California Council, AIA
1970 - 1974

Judith Lynch Waldhorn
Urban Planner
Stanford Research Institute
1972 - 1974

John B. Williams
Director, Redevelopment Agency
City of Oakland
1970 - 1972

Charles A. Zahn
Chief, Advance Planning Division
Contra Costa County Planning Departm
1971 - 1974

*Dates of service

## INTRODUCTION

As already stated, the legislative charge to the Advisory Group on Postearthquake Recovery and Redevelopment was to make recommendations which will assist materially in the orderly and controlled rehabilitation of areas damaged by earthquakes. After a disaster, the natural human tendency is to extend aid as soon as possible; but this haste, when related to recovery and redevelopment efforts, often causes problems for future generations. The advisory group's recommendations are meant to guide these efforts within a context that will minimize the repetition of postearthquake errors made in the past.

At the onset of the study, the group saw its overall task in terms of three typical subdivisions. First, what guidelines should be applied after a disaster, both in the immediate fervor of recovery and in the longer-range era of redevelopment? Second, what steps can be taken now, through land use controls or development restraints, to reduce susceptibility to seismic hazard, and to minimize the cost in time, life, and wealth during the postearthquake period? Third, what control mechanisms can be instituted before an earthquake, that would go into effect automatically in the postearthquake period to provide a framework for reconstruction and redevelopment, and also to minimize recovery problems and maximize the degree of seismic safety afforded future generations?

A fourth concern, soon added to the above, was to recommend that damaged buildings be immediately surveyed, using a standardized multipurpose form. This information would be useful in making important decisions immediately following a quake and in assessing which structures could be used safely and which should be completely abandoned. Besides facilitating immediate decisions, such an evaluation form would have two additional purposes: helping in long-term damage assessment to guide redevelopment plans, and serving as a standard reporting mechanism for the preparation of statewide statistics.

The group began its work by establishing a series of time-framed objectives, subdivided into various tasks and study areas. The first objective, dealing with the immediate postearthquake period, was to develop procedures for the rapid evaluation of structural damage and for control of the repairs and reconstruction. Within this objective, several tasks were listed for the establishment of priorities and for ensuring that post-disaster reconstruction, while as rapid as possible, would also conform to standards for the safe location of buildings and applicable structural specifications.

The long-term postearthquake era was the subject of the next objective, with tasks set in two major areas. The first task was an investigation of present methods used to pay for earthquake damage, including private insurance and government loans and grants. We also explored present means of compensating local political subdivisions for revenue losses incurred during postearthquake reconstruction.

Improving local building ordinances was another area of concern to us. While we recognize that specific recommendations in this area are the province of the Advisory Group on Engineering Considerations and Earthquake Sciences, we

would like to stress that such ordinance changes are as important postearthquake reconstruction as to pre-quake efforts to limit damage.

Pre-earthquake hazard reduction constituted the third of our objectives. this category we explored methods of determining whether buildings should strengthened or abandoned in areas of potential geologic hazard. We also ma some investigations into the state-of-the-art for evaluating geologic areas in ter of potential earthquake damage.

A special area of investigation was the postearthquake utilization a compensation of professionals. The group found a need to ensure that t services of engineers, architects, and other professionals would be immediate available after an earthquake, and that these professionals would be co pensated adequately for their services.

What follows is a discussion of our investigations into the subject postearthquake financial assistance, and a brief discussion on priorities, aft which we present specific recommendations in our major areas of concern. forming our conclusions and recommendations, we were guided by thr overriding considerations. First, to establish a necessary sense of *political reali* every recommendation was evaluated in terms of financial impact and t probability of implementation. A second evaluation criterion was the *state present knowledge,* particularly in such areas as correlating building locati with potential seismic hazard. Third, and in view of the limited knowledge, o recommendations place more emphasis on *actual post-disaster reconstructi methods,* and less on predictions, studies, and land-use controls.

## POSTEARTHQUAKE FINANCIAL ASSISTANCE

Individual self-help efforts are crucial after a disaster, but are usually ufficient to meet the total need for funds and services after a major thquake. Both individuals and local political subdivisions need recovery istance; this need has been recognized by the private sector through the ovision of insurance, and by the Federal Government through the provision of ns and grants.

The following sections present some major findings in the areas of insurance, ns, and grants. We have concluded that personal and public monetary needs lowing a disaster are not now being adequately met by any of these three nues. Earthquake insurance could supply only a minimal amount of the netary need, because so few property owners now carry such coverage. It has n repeatedly reported that Federal loans and grants constitute the majority disaster relief funds; but these funds are poorly administered, not disbursed ickly enough, and subject to capricious and conflicting regulations.

### urance

Insurance against loss is generally considered to be a function of private erprise. In the United States, multimillion dollar corporations exist primarily insure lives and property against loss or damage, using sophisticated actuarial les, loss schedules, and other criteria on which they base their premiums. To p these premiums within the average citizen's means, certain losses—such as se caused by earthquakes—are sometimes excluded from coverage, or are urable only at extra cost. Because the private insurance sector is limited in the ent to which it can expose its assets to any one disaster occurrence, it has n necessary for the Federal Government to interest itself in the insurance siness.

Adequate insurance protection can be considered one of the best ways to isfy the monetary needs of the private sector for postearthquake recovery and levelopment. Through an insurance system, the individual or the corporation pay for the necessary protection in an orderly manner.

The question of availability and cost of property insurance protection inst earthquake losses has been raised by a number of factions, and the nclusions drawn vary to some degree. However, there appears to be general eement that earthquake insurance is now widely available from the private urance industry at rates that most people can afford.

Since the San Fernando Earthquake of 1971, Federal, State, and local ncies have undertaken extensive investigations into the availability of thquake insurance. The private sector, too, has been studying this matter. The tional Committee on Property Insurance (NCPI), comprised of executives presenting a large segment of property insurors, has been working with the ailability of Essential Insurance Subcommittee of the National Association of surance Commissioners on an overall program for catastrophic risk insurance verage.

In connection with earthquake insurance, NCPI commented in June 1972 as follows:

> While the occurrence of earthquakes presents a widespread threat geographically—almost national in scope—the chance of catastrophic loss and the accompanying insurance problems are primarily found in the State of California. The NCPI is hopeful that the California situation can be used as a point of departure for an intensive study of solutions by the insurance industry working cooperatively with the National Association of Insurance Commissioners, and that this focused study will be of material assistance.
>
> The National Committee on Property Insurance recommends that a Special Study Committee be appointed by the Chairman of the Subcommittee, with the advice of the Insurance Commissioner of the State of California, from among members of the Subcommittee, the California Insurance Department, the National Committee on Property Insurance, the Reinsurance Association of America and domestic California insurance companies. That Committee would, of its own volition, solicit testimony from geological engineers, producer groups, public representatives, and the like, but its composition would be limited to professional insurance risk bearers and their state regulators.
>
> While it is apparent that earthquake insurance is, in general, broadly available and on reasonable terms, it also is established that only a very small segment of the public has purchased this desirable protection. It is agreed to be in the public interest to have earthquake insurance protection provided as broadly as possible, particularly with regard to residential properties. The development of appropriate means to encourage far broader earthquake insurance protection should be a basic objective of the proposed Special Study Committee, along with mitigation of insurance problems which would result directly depending on the magnitude of liability that would be created.*

After the above statement was issued, the groups concerned held further meetings and in San Francisco on November 2, 1972, the following proposal was unanimously endorsed at a joint meeting of the Catastrophe Perils Study Subcommittee of the National Committee on Property Insurance and the Availability of Essential Insurance Subcommittee of the National Association of Insurance Commissioners.

1. The most effective way to utilize available earthquake insurance is for all lending institutions, through appropriate government action, if necessary, to require all mortgagors of 1 to 4 family dwellings to purchase earthquake insurance.

2. The coverage should take the form of an additional peril or an endorsement rather than a separate policy.

3. The State should insist upon sound and stringent land-use requirements, improved building codes, and enforcement of such requirements

* NCPI, Report of June 13, 1972

and codes which are essential in the public interest, generally, as well as in the successful operation of the program.

4. A separate study of rates, forms, and deductibles should be made.

5. Reinsurance of the earthquake peril for such dwelling risks may be ceded to a voluntary reinsurance facility which could be established by those companies that wish to pool their earthquake premiums and losses. All cessions shall be made on a 100 percent basis.

6. Adequate reinsurance will be necessary. Reinsurance may be required from the public sector, if sufficient capacity is not available from the private sector.*

By mail vote in November, 1972, the National Committee on Property Insurance approved the proposal. The Executive Committee of the National Association of Insurance Commissioners met in Atlanta, Georgia, on December 1972, and accepted the proposal.

Studies indicate that the earthquake insurance problem arises because homeowners in earthquake-prone areas fail to purchase such insurance, not because companies fail to offer it. The extensive property damage resulting from the 1971 San Fernando Earthquake has led public officials and other responsible citizens to recognize the need for positive action that would inform property owners about the wisdom of protecting themselves financially against possible future seismic disaster.

Consequently, some insurance companies and their agents have made special efforts to promote earthquake coverage for dwellings. Three major insurance companies have announced a reduction in earthquake insurance rates for homeowners' policies, along with attendant publicity to create a general awareness of the need for this type of coverage. It is anticipated that many more insurance companies will adopt a similar approach.

We as a group support the NCPI subcommittee in its recommendation that earthquake insurance be required of all borrowers who are purchasing one- to four-family dwellings.†

## Loans

Several similarities are evident between insurance and loans. Both cost money, both are usually the products of private enterprise, and both are generally provided by multimillion dollar institutions.

However, loans are usually more difficult to obtain than insurance, because the borrower must assure the lender that he can repay the loan, with interest, within a reasonable period of time. For larger loans, the borrower must pledge something of value equal to, or greater than, the amount of money he wishes to borrow. Under normal conditions, this equity pledge is of less importance, but

* Minutes of November 2, 1972 meeting of the NCPI Catastrophe Perils Study Subcommittee and NAIC Availability of Essential Insurance Subcommittee.

† Property insurance company manuals of rules and rates define one- to four-family dwellings for purposes of fire and extended-coverage insurance.

after an earthquake the borrower may find that the diminished value of h property restricts his ability to furnish adequate collateral. Consequently, h borrowing capacity may be insufficient to meet his recovery needs.

In these days of extensive credit buying, both individuals and businesses fin themselves constantly in debt, and at the limits of their ability to repay the normal indebtedness. The addition of a postearthquake rehabilitation loan ma be unfeasible if it cannot be repaid, especially from the diminished earning which often follow a disaster. Collateral requirements, high interest rate ceilings on borrowing capacity, and other factors prevent many people and loc political jurisdictions from obtaining disaster rehabilitation loans from privat commercial sources. Therefore, some form of Federal assistance is essential.

From the turn of the century until 1950, when the nation's firs comprehensive Federal Disaster Relief Program was enacted, there were tw principal means of providing Federal disaster relief. First, the services of the U.S Corps of Engineers were made available to repair and reconstruct publi facilities. Second, special "single disaster assistance" legislation was enacted t provide relief to victims and private property owners.

With the passage of Public Law 81-875 in the 1950s, financial assistance wa provided directly to public jurisdictions without utilizing the Corps of Engineer as the prime source of assistance. Its major provisions were designated to provid funds for State and local governments to restore essential public facilities. As companion program to assist private property owners, the Small Busines Administration (SBA) was authorized to make disaster loans for repair an restoration to businesses and to individuals unable to obtain commercial loans These are long-term, low-interest loans which contain excuse clauses to forgiv portions of the interest and/or principal. The Farmers Home Association, th Federal Housing Administration, and other Federal agencies have similar disaste loan authority for specific types of businesses or individuals.

On the basis of experience with Public Law 81-875, and the companion SBA program, the Congress passed Public Law 91-606 in December, 1970. This legislation was designed to provide, among other things, for greater flexibility in the administration of the Federal Disaster Relief Program for public agencies. The SBA loan service provisions were also modified to provide for cash grants to private property owners, in addition to the low-cost, long-term disaster loans.

The experiences following the San Fernando Earthquake of 1971 indicated serious problems in the administration of these programs, particularly those of the SBA. Among the things complained about were slowness in processing applications, inadequate inspection of damage and work completed, and inequitable allocation of funds by a formula which, in some instances, provided the greatest amount of assistance to those with comparatively minor needs. Another major complaint was that the SBA staff was totally inadequate for handling the massive workload and that the SBA procedures completely bypassed existing local government agencies which could have handled the entire loan package, from application to final inspection. Finally, SBA gave its loan funds directly to property owners, with no follow-up to ensure that this money was actually spent to repair the disaster damage.

We believe that some Federal loan program is necessary, particularly for those property owners who do not purchase insurance. However, we also believe

t present inconsistencies in the applicable regulations must be resolved, and t the method of administration must be changed.

## nts

Neither insurance nor disaster loans can satisfy the total postearthquake netary need. Some people, especially those with low incomes, can neither ain nor afford insurance or loans. Local governments do not have the legal hority nor, in most cases, the cash reserves for post-disaster reconstruction, ch less for emergency relief. Direct monetary assistance from the Federal vernment has proven to be essential.

Traditionally, the American National Red Cross and other private and lanthropic organization have provided grants to individuals to assist with abilitation after a disaster. They provide for immediate shelter, food, thing, and medical supplies when no other source of funds is available. wever these organizations usually depend on public donations, and in the past ade, donations have not kept pace with the increasing need for grants.

The Federal Government also provides a certain amount of direct assistance disaster victims in the form of goods and services. Under the provisions of blic Law 91-606, it can provide temporary housing at little or no cost, food mps, medical care, and unemployment assistance. Many other Federal grams providing routine assistance, such as welfare and Social Security, ntinue even during disasters. The Federal Government also provides direct nts to the states and their political subdivisions, to compensate for revenue ses due to the impact of a disaster on the tax base. Other grants are made for construction purposes on a project basis.

No single existing grant program can satisfy all the needs of individuals or vernments in time of disaster. Our investigation of the matter has shown that ile flexible combinations of improved programs may remove some of the esent deficiencies, they exhibit many of the same difficulties that exist in the deral loan programs: overlapping requirements, poor administration, under-nding, and unstable regulations. In fact, in some cases the Federal loans and ants actually compete with each other.

It has been suggested that the Federal Government expand its present saster grant program, either directly or in cooperation with the states. We lieve, however, that the same benefits could be achieved by amending existing deral grant programs for use in disaster recovery. In that way, experienced cal welfare, social service, employment, and housing agencies, which are ready staffed and equipped to disburse funds, could be promptly assigned to saster relief.

## PRIORITIES

In dealing with its diverse objectives, the group could not assign specifi priorities to the various actions that the group believes should be take Therefore, throughout the following recommendations, we stress the benefits c the immediate use of present knowledge. However, we also believe that whereve priorities *are* set in connection with seismic safety they should be evaluate according to the following concepts:

1. Public research funds should be used to conduct seismic safety research i areas of immediate use for minimizing earthquake damage.
2. All recommendations should be evaluated accurately with regard t financial impact and political feasibility. Only with such knowledge can th public make rational choices about taxation to finance State and Federal disaste programs, to pay for strengthening or abandoning structures, and to alte existing development trends.
3. Most of our recommendations, and some of those made by the othe advisory groups, are based on current knowledge and can be implemente immediately. Much is known about recovery from seismic disaster, and tha knowledge should be used immediately in preparation for the next majo earthquake.

## RECOMMENDATIONS

### mediate Postearthquake Procedures

#### 1. Local Disaster Plans

The appropriate State agency should prepare model local disaster plans adoption and implementation by cities and counties jointly and individually. plans should include guidelines and provisions for the rapid inventory and uation of the extent of earthquake damage.

*Discussion.* Cities and counties should be required, by State law, to pt emergency plans. The plans should be tested by various methods, uding the development of "damage scenarios." Such scenarios are now being eloped for earthquakes of different magnitudes in San Francisco and Los eles. They include an assessment of local, State, and Federal disaster gram capabilities, and have proven to be a valuable exercise.

The designated State agency should develop a two-step procedure for uating the extent of earthquake damage. Step one would include an mediate emergency survey to determine whether or not buildings are safe occupancy, with preliminary dollar estimates of the magnitude of the losses standardized procedures for posting unsafe buildings. Step two would ude a detailed resurvey of buildings posted as unsafe, and others severely naged, to record the type and extent of damage. This information would st those who must decide whether to rehabilitate or demolish buildings.

There are no generally accepted criteria for the evaluation of the degree hazard created by earthquake-damaged buildings. Therefore, the State agency uld develop the necessary guidelines in consultation with the Structural gineers Association of California (SEAOC). A commentary on the guidelines uld also be developed and widely distributed to local building departments, uctural engineers, architects, and other professionals.

Procedures should be developed for the standardized reporting of nage statistics in terms of numbers of people affected, dollar losses for nolished and repaired buildings, and monetary losses related to disaster- used unemployment, reduced business activity, and decreased public revenues.

*Implementation.* Appropriate State and Federal funding would be uired to aid in the implementation of this recommendation. State law would e to be amended to require the adoption of emergency plans by cities and nties.

#### 2. Damage Assessment Forms

The appropriate State agency should develop standard report forms so t damage assessment data will be gathered in a consistent manner by State ncies and local jurisdictions. The California Commission on Seismic Safety uld be established to implement the postearthquake damage assessment ormation program.

*Discussion.* These forms would be developed after a detailed study of survey procedures used by the County of Los Angeles and the revised

procedure developed by the City of Los Angeles after the 1971 San Fernan Earthquake. (See item 1 under Supplementary Information for list of forms.)

The appropriate State agency should test the feasibility of developi standard computer programs for processing the damage assessment data. T standard report form should be tested under various kinds of simulated disast conditions, including earthquake, fire, windstorm, and flooding. Standardiz damage report forms should be supplemented by a manual, and both forms a manuals should be distributed to appropriate central storage locations f immediate availability in the event of a disaster.

*Implementation.* The recommended California Commission on Seism Safety should be appointed by the Governor and funded by the State legislatu

3. **Seismic Information File**

A central file should be set up to consolidate all earthquake dama information in California; the information in this file would be available to a group or individual with legitimate need for such knowledge.

*Discussion.* Information about seismic hazard and disaster is needed l building-code agencies, property owners, insurance companies, structural en neers, architects, lending institutions, tax agencies, and groups or individu carrying out research activities.

*Implementation.* The file should be developed and coordinated by t previously recommended California Commission on Seismic Safety. The Sta legislature should appropriate the funds necessary to prepare the file and ma it readily accessible at various locations throughout the State.

4. **Damage Assessment Services**

The California Commission on Seismic Safety should instruct each ci engineer or building official, as appropriate, to develop a list of compete professionals from the private sector, who would be immediately available f building-damage inspections. The engineer or official concerned should coor nate these activities with the overall county plans outlined in recommendation of this set.

*Discussion.* All earthquake damaged buildings must be inspected a classified following an earthquake.When the inspection is performed immediate by a competent professional in an organized manner, plans for the strengthenin demolition, or rehabilitation of the affected structures will be expedited.

*Implementation.* The California Commission on Seismic Safety shou establish qualification standards for the professionals to be employed. The lis of professionals for postearthquake structural evaluation should be submitted t and reviewed by, the above commission. Furthermore, the commission shou prepare a statewide list of qualified professionals for the expedient mobilizati and movement of such persons into disaster-stricken areas when local resourc are insufficient to do the job.

5. **Reconstruction Priorities**

The State Office of Emergency Services (OES) should develop that part f ne damage plans* involving both immediate and long-range reconstruction of s ntial facilities. OES should set priorities for the use of critical materials owing a disaster, if necessary.

*Discussion.* The State Office of Emergency Services (OES) should review history of recent earthquakes to determine which kinds of facilities were of cal importance in the immediate postearthquake period. Priorities should be gned for the immediate reconstruction of life-support and disaster mitigation ities in case there are aftershocks. Priorities for longer-term reconstruction uld be assigned to facilities of less urgent importance.

*Implementation.* OES already has the power to organize the distribution critical materials and to coordinate local efforts during a disaster. This ommendation merely suggests a more effective use of existing authority.

6. **Area-Wide Restoration Control**

The California Emergency Services Act should be amended to establish a rd of reconstruction review. The board's primary responsibility should be to elop plans and guidelines for the restoration of facilities and services in local mmunities after an earthquake†.

*Discussion.* The damaging effects of earthquakes are rarely limited to boundaries of a single political subdivision. Major earthquakes, especially in congested San Francisco and Los Angeles areas, can cause extensive damage dozens of local jurisdictions. Legal controls can be exerted within individual sdictions to ensure that the most essential facilities are given the highest ority for restoration. However, there exists no such control mechanism for establishment and enforcement of priorities on a multi-jurisdictional, a-wide basis. Thus, in situations where restorative resources are limited, one isdiction could undertake the reconstruction of non-essential facilities while a ghboring jurisdiction might be unable to secure the manpower and material cessary to return the most essential facilities to operation.

*Implementation.* The recommended board should be established by legislature, with adequate funding to carry out its activities.

7. **Building Repair and Reconstruction**

The appropriate State agencies should prepare model ordinances and delines to control the postearthquake repair and reconstruction of damaged ildings.

ee recommendation 1 of this set.

This function could be made a responsibility of the California Commission on Seismic Safety cited in recommendation 2 of this set.

*Discussion.* In preparing the above models, the agencies involved shou use as guides Volume IV, "Dangerous Buildings," of the *Uniform Building Co* (current edition), and the 1971 City of Santa Rosa Resolution 9820. The mod ordinances should include provisions for adequate plan checking, inspection repair and reconstruction work, and accurate reporting of repair costs, to ensu that local governments require complete code-compliance for all buildings. T recommended models would also provide a post-disaster standard to be appli to older structures built in some areas before local codes set minimu requirements.

*Implementation.* State agencies have the knowledge and capacity, wi the assistance of such organizations as SEAOC, to prepare such mod ordinances and guidelines. The final versions would, of course, have to formally adopted by the appropriate local jurisdictions.

## Long-Term Postearthquake Actions

### 1. Insurance Requirement

The State of California should adopt the principles set forth in t proposal by the Joint Subcommittee of the National Committee on Proper Insurance and the National Association of Insurance Commissioners. (See pag 102-103, items 1 through 6)

*Discussion.* According to the records of the State Department Insurance, 189 companies sold earthquake insurance in California in 197 Several of these companies have conducted a publicity program, have lowere their rates, and are actively competing for earthquake insurance business, b have written relatively few additional policies in recent years. Requirin property-loan borrowers to purchase earthquake insurance, as presently done f fire and extended coverage, is a feasible approach and generally acceptable to th private insurance sector.

*Implementation.* Further study of this matter should be conducted b the Joint Committee on Seismic Safety in conjunction with the Governor Earthquake Council to determine a legislative course of action.

### 2. Insurance Information

It should be required that the insurance industry make a coordinate effort to inform all property owners in California of the importance an availability of earthquake insurance. Each solicitation for insurance covering fir protection, and each renewal offering, should include an offer of earthquak insurance and a description of the terms, including the premium and applicabl deductibles.

*Discussion.* The step toward implementing this recommendation ha already been taken by the State Department of Insurance, as indicated in thei Bulletin No. 72-13, dated September 15, 1972, which covers earthquak insurance as well as flood and crime insurance. (See item 2 under Supplementar Information.)

*Implementation.* The legislature should resolve that the State Depart- of Insurance be empowered to develop and enforce a plan that would re the support of the insurance industry for the above recommendation.

**. Federal Loans and Grants**

The legislature should, by joint resolution, memorialize Congress and the opriate executive agencies to stabilize present Federal regulations for loans rants to disaster areas under Public Law 91-606.

*Discussion.* Current administration of the 1970 Federal Disaster Relief as been called a scandal by the Chairman of the U.S. Senate Appropriations mittee. The manner in which interest rates are extended and debts to the Treasury are forgiven appears capricious and unrelated to the individual's s. As a result, many homeowners ignore available earthquake insurance use they feel cushioned by the ever-slackening Federal disaster regulations.

*Implementation.* The stabilization of PL 91-606 would require both dments to that law and alteration of present Federal guidelines and nistrative regulations.

**. Federally Subsidized Housing**

The legislature should, by joint resolution, memorialize Congress to ire that adequate earthquake insurance, or guarantee of funds for immediate rs, be available for all housing units produced or rehabilitated through the ic housing program of the Federal Government. Similar insurance, with ral assistance if necessary, should be made available for all homes tructed or rehabilitated through any Federal subsidy program.

*Discussion.* Although only three percent of the housing in the United s is federally subsidized, that portion represents an important source of nt, reasonably priced homes for many millions of people of low and erate income. Consequently, this resource should be protected against ic and other natural hazards.

Eventually, earthquake insurance should be made mandatory for all ing units, including structures accessory thereto. However, we believe that it ld be more reasonable to begin with federally subsidized units and extend nsurance requirements to all structures later.

*Implementation.* The legislature should memorialize Congress and the ral Government to require earthquake insurance for federally subsidized es as recommended above.

**5. Federal Disaster Relief Payments**

The legislature should, by joint resolution, memorialize Congress to nd the definition of "substantial loss of revenues" in PL 91-606 to include ncome sources of local government. In addition, PL 91-606 should be nded to permit the early release of a portion of the Federal aid authorized communities damaged by major disasters.

*Discussion.* A significant reduction in revenues from any source immediately felt by local governments. Large expenditures for emergen actions must come from existing funded programs, and unless offset by ot sources of revenue these emergency expenditures could reduce or delay essen public services.

Public Law 91-606 authorizes the President to make grants to any lo government which loses substantial tax revenue because of lower prope evaluations after a major disaster. In addition, a 100 percent contribution can made, under the law, to state and local governments for the repair, rec struction, or replacement of all public installations such as streets, highwa buildings, sewers, disposal plants, water mains, water supply works, and flo control facilities.

Most California political subdivisions operate on strict budgets, a reduction in revenue from any source must be considered substantial if prevents the political jurisdiction from meeting its financial commitments providing essential services. Therefore, the present definition with regard substantial loss should be changed to include all revenue sources, not j property tax. Furthermore, sufficient Federal funds should be immediat available to allow for the prompt resumption of services vital to public hea and safety.

The 1970 Federal Disaster Relief Act also authorizes the President grant payments to state or local governments for (1) debris removal, (2) to off property tax losses, and (3) to repair, restore, or replace damaged or destroy public facilities. Ordinarily, payments for debris clearance or reconstruct cannot be approved until a full and complete appraisal of the loss has be made, contracts are awarded, and the project is underway. Supplement payments to offset property tax losses cannot now be made until the prope has been reassessed to determine the exact amount of the loss. Since reassessment process is presently too slow, the waiting period for supplement payments should be shortened to help keep hard-pressed jurisdictions fr having to curtail essential public services or borrow funds for daily operations.

The increase of property taxes after earthquakes has been an emergen measure taken by cities and counties to compensate for their overexpendit of funds. Most local governments will attempt to correct the shortages essential equipment soon after an earthquake; therefore, they need to get necessary funds as rapidly as possible.

*Implementation.* The State legislature should memorialize Congress amend Public Law 91-606 as necessary.

## Postearthquake Utilization and Compensation of Professionals

### 1. Utilizing Professional Services

Public agencies at all levels should supplement their own staffs, necessary, by utilizing the professional capabilities of private practitioners in

geering, architectural, and planning disciplines in an expeditious and ient manner.

*Discussion.* The expertise and competence of California's practitioners nnection with seismic safety is recognized internationally to be of a high d. They are experienced in seismic problems, well acquainted with local itions, and are readily available.

*Implementation.* Existing procedures for the selection of and con- ing with private practitioners should be improved to expedite their inclusion ie postearthquake recovery effort. This can be best achieved by having lic agencies at all levels work with the various professional societies to olish specific procedures and guidelines before any emergency. (See item 3 r Supplementary Information.)

**2. Setting Contract Conditions**

Whenever engineers, architects, and planners are retained by a public cy as consultants in connection with postearthquake reconstruction, the pensation for their professional services and the definitions of their nsibility and liability should be clear and equitable.

*Discussion.* It is axiomatic that competent and complete professional ces are necessary for sound planning, design, and construction, and that table reimbursement is necessary to pay for these services. However, the nal contracting methods and practices cannot be employed in postearth- e situations without causing serious delays in both the commencement of k and payment for services rendered.

*Implementation.* Model agreements for professional services and selec- procedures for private engineers, architects, and planners retained by public cies should be developed after consultation with existing professional eties. These should be ready for use following a major earthquake, both ediately and in the longer-range recovery and redevelopment period. (See s 4 and 5 under Supplementary Information.)

## Earthquake Hazard Reduction

**1. Geologic Hazards Mapping**

The State should expedite its cooperative program with the Federal ernment to map and evaluate geologic hazards at levels of detail suitable for ing land use decisions and regulating development.

*Discussion.* The mapping and evaluation of geologic hazards at levels of il appropriate for decision making by public and private groups should be an oing program to develop this information sufficiently in advance of need. s program would develop the information through the coordinated efforts of ral Federal and State agencies and educational institutions.

*Implementation.* The program could be coordinated by the Califor Division of Mines and Geology, as an extension of the Urban Geology Mas Plan, and participants could include CDMG's own staff, the U.S. Geologi Survey, and the U.S. Soil Conservation Service. Among its constituent parts, could include the precise mapping of faults, fault zones, and fault traces beg under SB 520, the Alquist-Priolo Geologic Hazard Zones Act.

2. **State Geotechnical Assistance**

The State should institute a program to provide technical assistance earthquake-probability and geologic hazards assessment to jurisdictions whi prepare and implement comprehensive plans.

*Discussion.* The State must provide planning jurisdictions with hazar data and resources adequate to formulate and implement local comprehensi plans. This State assistance is necessary because local jurisdictions seldom ha the resources to prepare their own technical information.

*Implementation.* This program should be coordinated by the State Offi of Planning and Research, since the information must be in forms useable b local planning agencies. The program should utilize the services of other Sta agencies, Federal agencies, and universities. The plan-preparation efforts mig be subsidized by the Federal Government's planning assistance grants ma either directly to the State office or parts of comprehensive planning gran awarded by the California Council on Intergovernmental Relations to cities a counties.

3. **Development of Geologic and Structural Hazard Data**

The California Council on Intergovernmental Relations and the Feder Government should revise their priorities to encourage the development adequate geologic and structural-hazards information for plan preparation a implementation purposes.

*Discussion.* While the State and the Federal Government have bee reluctant in recent years to authorize the use of planning grants for inventori of geologic and structural hazards, these inventories are essential if land u controls are to be used to reduce disaster losses. Alternative programs planning assistance and urban renewal planning grants may be available for, adaptable to, the development of data on earthquakes, floods, and other suc hazards, but these two programs appear to be the only ones now available assist in the preparation of structural hazards information.

*Implementation.* The State legislature should memorialize the Feder Government to change the Federal priorities which are, in turn, reflected State priorities. The legislature should also recommend that the Council o Intergovernmental Relations enter into discussions urging the Federal Gover ment to initiate the changes.

**4. Provision of Updated Hazard Information**

The State should provide up-to-date information on geologic hazards and ctural conditions to local governments following disasters, and urge the ral Government to make planning grants available for the provision of such mation.

*Discussion.* The most accurate information on geologic disruptions and ctural damage is obtainable immediately after a disaster, a time when this rmation is also needed the most for the planning and implementation of nstruction programs. Unfortunately, in the immediate post-disaster period, units of government are least able to supply the resources for surveys, and State and Federal governments cannot now provide these resources rapidly gh.

*Implementation.* The State aspect of implementation should be achieved ugh legislative authorization and executive direction. This action should ire that the State Office of Emergency Services call upon the California sion of Mines and Geology and the Federal Government to provide, or see, these services in accordance with planning criteria established by the e Office of Planning and Research in cooperation with the affected political divisions.

**5. Building Inspection Records**

The State should sponsor studies and seminars to determine how local ding inspection records can be kept to identify hazardous structures and to rtain the extent of structural deficiencies on an areawide basis for planning implementation purposes. If uniform and reasonable procedures for ntaining key files can be devised, these procedures should be required of all nit-issuing jurisdictions.

*Discussion.* Building inspection records constitute a potential source of tinually updated information on structures, for both planning and implemen- on purposes. However, present methods of record keeping hinder the ulation and interpretation of these records for such purposes.

*Implementation.* The State should assume a leadership role in finding able techniques and in obtaining the necessary cooperation of permit-issuing sdictions.

**6. Safety Compliance of Public Improvements**

The State government should direct its agencies to consider the seismic ty elements of State, regional, and local comprehensive plans, before funding lic improvements.

*Discussion.* Federal facilities, State facilities, and federally assisted lic improvements all influence development in California. If grants are rded for public improvements which are incompatible with existing

comprehensive plans, policies to mitigate hazardous conditions may circumvented. Some of these improvements fall in the category of criti facilities which, by their nature, constitute potential hazards and mu therefore, be located in accordance with knowledge of local conditio Although higher levels of government cannot be compelled to conform to t comprehensive plans of lower ones, they should certainly take these plans in consideration before they make their siting decisions.

*Implementation.* This recommendation can be implemented eith through executive order or through legislation. The simplest approach would for the State legislature to request that the Governor issue the necessary ord to agencies under executive control, and, at the same time, to utilize the servic of the State Executive Office to request that the President so direct the Fede agencies.

### 7. Review of Public Improvement Plans

State planning law dealing with the referral of improvements projects local planning agencies should be strengthened to discourage location of pub improvements in areas of identified seismic hazards.

*Discussion.* Section 65402 of the Government Code should be amend to make it clear that local planning commissions are charged with the siti review of public and semi-public projects that would otherwise escape su review under zoning regulations. The amendment should require that loc planning commissions include seismic considerations in their reviews (i.e conformance to safety and seismic safety elements and related information other parts of the general plan).

Section 65402 could also be amended to require that a negative findi by a planning commission for a project directly under the control of its pare legislative body would have to be referred to that legislative body, and that t project would be "frozen" until the legislative body acted.

*Implementation.* The legislature should amend State planning law, necessary, using the services of the State Office of Planning and Research draft the required amendment.

### 8. Land Use Controls

Zoning enabling legislation should be modified to indicate that t prohibition of development, as well as the exercise of controls over land uses a over the type and density of construction in order to restrict development areas of identified seismic risk, is in the public interest.

*Discussion.* Just as zoning is considered by planners to be one means implementing a general plan, so too should it be considered a measure to contr development in hazardous areas. Zoning is a potent influence on all private a most semi-public development, and it should include hazard-control steps, su as prohibitions against land-use permits for private critical facilities high-occupancy structures in identified high-risk areas.

*Implementation.* The legislature should expressly sanction the use of ng to restrict development in identified hazard areas.

**). Development Controls**

Enabling legislation covering subdivision and planned unit development ld be modified to indicate that the regulation of structures, services, and uses in hazardous areas is in the public interest.

*Discussion.* Public review of subdivisions and planned unit development ects—both private and semi-private—constitutes a substantial control over lopment. Whereas zoning and specific-plan regulations typically affect the ess leading up to a development proposal, subdivision and planned unit lopment regulations deal with the public's response to developers' proposals. latter ordinances not only require that proposed developments comply with general plan and official specifications, but they also impose specific litions and typically involve several reviews of a given proposal before it is ted final approval. Thus, these controls cannot simply require that a osed development respect the known hazards, they must also see that the loper conducts whatever investigations are necessary to ensure the total ty of the development.

*Implementation.* The legislature should amend existing enabling legisn to encourage local governments to make subdivision and planned unit lopment regulations more effective in dealing with hazardous site condis.

**10. Geologic Reports**

Federal, State, and local governments should require geologic reports on development projects which involve significant land-use or environmental siderations, and which receive Federal, State, or local funding or guarantees. s should include all federally insured subdivisions and development projects, well as publicly funded improvement projects.

*Discussion.* The report in question would record the results of a ndatory geologic study or investigation, and would be used by public agencies h in performing project reviews and in exercising development controls. The logic report could be either a separate document or one incorporated into ne other required report, such as an environmental impact statement.

*Implementation.* The above recommendation should be implemented ough legislative action, and in this regard the Governor's Earthquake Council recommended the following:

The Department of Conservation should propose legislation for the 1973 session that would make the following procedure mandatory for all cities and counties, including charter cities and counties: A preliminary geologic report should be prepared, in the same manner that preliminary

soil reports are now required, for all subdivisions and for critical structures and facilities, and other public and private projects that have significant land-use considerations, except for those areas that are mutually agreed upon to be of low risk by the State Geologist and local government.*

The legislature may also request that the Governor require geologic repo from State agencies undertaking construction projects. He may also requ similar reports from various Federal agencies planning construction projects the State.

**11. Hazard Area Redevelopment**

The State law should be amended to permit redevelopment of both ar of identified geologic hazard and areas already damaged by seismic disturban or other natural disasters, if such redevelopment is appropriate.

*Discussion.* This recommendation originated with the Advisory Gro on Land Use Planning, but has been expanded here to include hazards other th those of a direct seismic character. The proposed amendment is needed sanction the consideration of physical hazards in redevelopment plans of long-range nature, as well as in establishing project eligibility. Currently, the l concentrates on questions of design and structural deficiencies in areas that c be designated as "blighted," but slights land deficiences of a geologic physiographic character.

*Implementation.* The California legislature can effectuate this reco mendation through the passage of a bill amending the State's redvelopment la The services of the State Office of Planning and Research should be utilized drafting the legislation.

**12. Planning for Post-Disaster Redevelopment**

The State should encourage its political subdividions to provide f post-disaster conditions in their general plans.

*Discussion.* State planning law now requires that cities and counti consider geologic and other hazards in the preparation of their general plans, b the emphasis is on preventing or limiting the extent of disasters. Attentic should also be given in these plans to the changes in circumstance that m *follow* a substantial disaster. History offers too numerous examples communities that failed to redesign structures or change land uses in heavi damaged areas because they did not have the plans and programs to carry o such redevelopment soon enough after a disaster.

*Implementation.* Recommendations to provide for post-disaster co ditions in general plans could be included in guidelines for mandatory gener plan elements being developed by the State Council on Intergovernment

* *First Report of the Governor's Earthquake Council,* November 21, 1972, p. 4

ions. The post-disaster recommendation in these guidelines should also implementation measures that may be needed to carry out the respective nts, such as new zoning districts and new programs. The legislature should consider making the redevelopment element of the general plan mandatory risdictions engaging in redevelopment, and making Community Facilities- ies elements mandatory to ensure adequate coverage in their general plans.

## SUPPLEMENTARY INFORMATION

The following documents provide additional detail and models for perso concerned with specific recommendations.

1. Damage assessment forms from Los Angeles County, developed after t San Fernando Earthquake of 1971.

   a. Damage survey form
   b. Sample of how to fill out damage survey form
   c. Computer printout of the above information
   d. Damage survey work sheet
   e. Notice of building demolition

These are available from the Department of County Engineer, Los Ange County, 108 West Second Street, Los Angeles 90012, (213) 974-7147.

See recommendation 2 under "Immediate Postearthquake Procedures."

2. California Department of Insurance Bulletin No. 72-13, dated Septemb 15, 1972.

TO: All Insurers Licensed to Transact Property Insurance

SUBJECT: Distribution of Information Re Availability of Flood, Eart quake, and Crime Insurance.

Available from the Department of Insurance, 1407 Market Street, S Francisco 94103, (415) 557-1126.

See recommendation 2 under "Long-Term Postearthquake Actions."

3. California Council, American Institute of Architects, documents:

   a. *Architect/Engineer Selection Procedures in Federal, State, and Lo Agencies,* August 24, 1972.

   b. *Comprehensive Architectural Services,* CCAIA Document No. 100- (1972)

These are available from CCAIA, 1736 Stockton Street, San Francis 94133, (415) 986-0759.

See recommendation 1 under "Postearthquake Utilization and Compe sation of Professionals."

4. Associated General Contractors of California, Inc., *Plan Bulldoze Disaster Relief Contract and Contract Provisions.*

Available from AGC, 301 Capitol Mall, Sacramento 95814, (914) 444-643

See recommendation 2 under "Postearthquake Utilization and Compe sation of Professionals."

5. Engineering and Grading Contractors Association of California, *Und standing and Agreement Re EGCA Support of Disaster Preparedness and Relie*

Available from EGCA, 1517 "L" Street, Sacramento 95814, (91 443-8144.

See recommendation 2 under "Postearthquake Utilization and Compe sation of Professionals."

# Report of the Advisory Group on Land Use Planning

## ADVISORY GROUP ON LAND USE PLANNING

Charles T. Blair, *Vice Chairman*
Principal
Daniel, Mann, Johnson & Mendenhall
1970 - 1974*

Eric Borgwardt
Planning Director
City of Sausalito
1970 - 1971

Roy Cameron
Planning Director
County of Santa Clara
1970 - 1974

Lloyd S. Cluff
Vice Pres. and Prin. Engineering Geologist
Woodard-Lundgren & Associates
1970 - 1974

Samuel J. Cullers
Acting State Planning Officer
State of California
1970 - 1972

Rolf Eliassen
Professor of Civil Engineering
Stanford University
1970 - 1971

Michael Heyman
Professor, School of Law
University of California
1971

Thomas H. Hughes
Attorney-at-Law
1970 - 1974

Dale T. James
Regional Environmental Standards Office
Department of Housing and Urban Develc
1972 - 1974

Arthur G. Keene
County of Los Angeles
1972 - 1974

George Mader, *Chairman*
Planning Consultant
William Spangle & Associates
1970 - 1974

Donald Nichols, *Vice Chairman*
Geologist
U.S. Geological Survey
1970 - 1974

John B. Passerello
Governor's Office
State Office of Planning and Research
1973 - 1974

Sherwood Stockwell
AIA
Bull, Field, Volkmann & Stockwell
1970 - 1974

John Tooker
Acting Director
State Office of Planning and Research
1971 - 1973

Samuel E. Wood
AIP
Planning Consultant
1970 - 1974

*Dates of service

## INTRODUCTION

arly in its existence, the Advisory Group on Land Use Planning realized a as a first step, it should recommend that city and county general plans be qired to include considerations of seismic safety. On the basis of this c nmendation, the Joint Committee on Seismic Safety introduced a bill to i effect in the 1971 legislative session; this bill was subsequently enacted into w In addition, the advisory group has been active in formulating legislation— s eventually adopted—instituting a strong-motion instrumentation program in a ornia, regarding the safety of dams, and requiring the mapping of active t s in the State. The group has also proposed changes to assessment legislation : ng with geologically hazardous lands.

n the course of functioning as a group, we have educated ourselves in the n use planning aspects of seismic safety; an analysis of the 1971 San e ando earthquake, with respect to land-use practices, was most helpful in this n ection.

As a group, we believe the proper incorporation of seismic considerations in e planning process requires at least (1) the availability of adequate geologic f rmation, (2) the correct utilization of such information, and (3) the i ication of reasonable seismic safety standards. We believe, further, that there c ld be State legislation to ensure that these requisites are fulfilled in n ection with the planning process at the State, regional, and local levels. C rdingly, two objectives are expressed by the recommendations made in this p rt: (1) the State should assume the added responsibilities of providing a ance and reviewing, when necessary, either directly or through regional a cies, land-use decisions made at the local levels; and (2) the planning process t he local level should be improved and strengthened through the use of a tional tools to achieve greater seismic safety.

With respect to the first objective, we find a clear need for a continuing s mic-safety role at the State level. We therefore believe that an appropriate a ty—such as the seismic safety commission recommended by the Advisory G up on Governmental Organization and Performance—should be established t arry out statewide seismic safety programs and policies.

From a land-use planning standpoint the State's responsibility should i ude:

**State Planning.** (1) Geologic conditions are so varied in California that z iled zoning may be impractical at the State level; nevertheless, general e ewide guidance is needed. Specific recognition of seismic and geologic p blems should be reflected in a statewide comprehensive plan governing w th. Areas of critical seismic and other geologic hazards that span several t tical jurisdictions should be recognized and this knowledge used by regional , local agencies to provide at least a common minimum level of safety. (2) t e planning laws should be reviewed and revised as needed to encourage, a ng other things, the application of imaginative and innovative regional and l land-use plans to reduce seismic hazards.

**Information and Technical Guidance.** (1) Greatly increased amounts of ba geologic information should be provided throughout the State, preferab through regional agencies or, if necessary, directly by the State, in a coordinat effort with the Federal Government and with private firms. (2) Geotechnic review assistance, where not feasible at the local, subregional, or regional leve should be available from the State. (3) Land use analysis and research should made available to provide alternative solutions to seismic and geologic problem By means of the foregoing, the State, either directly or through its region bodies, could provide necessary leadership and assistance to cities and counti

**Planning Review and Approval.** The State should assume a major new role reviewing the adequacy of local plans and regulations with respect to seism safety. This could be done through a new coordinating and watchd commission functioning largely through new or existing regional agencie Regional or, where necessary, State certification of local compliance wi mandated seismic safety elements and State guidelines also seems appropriate. addition, major subdivisions, planned communities, and critical structures mig well require approval at the regional or State level with regard to acceptab levels of seismic safety.

**Local Planning.** At the local level, the planning function is carried out large through the preparation and administation of general plans, zoning regulation subdivision regulations, building and grading regulations, construction of publ facilities, and urban renewal programs. In each of these planning function specific attention should be given to seismic safety, in some cases, by expandi land-use planning law to provide additional tools to local governments for th regulation of land use, and, in other cases, by requiring conformance to Sta standards. For example, preliminary geologic reports should be required prior t adoption of zoning within seismically hazardous areas, geologic reports shou accompany all applications for subdivisions in areas of questionable geolog stability and within active fault zones; local jurisdictions should provid competent technical review of geologic reports for building and grading permit reports of geologic investigations, where conducted, should accompany all lan transfers; and definitions of blighted areas should include an analysis of geologi hazards. The intent of any State legislation should be to assist local jurisdictio in performing their responsibilities.

To facilitate an organized discussion of the problems and proposed solution the recommendations in this report are presented under six major topics a follows:

1. Land Use Planning.
2. Zoning Regulations
3. Subdivision Regulations
4. Building, Grading, and the Sale of Property
5. Geotechnical Assistance for Local Governments
6. Additional Measures

## LAND USE PLANNING

### ackground

Land-use planning involves the prescription of the best possible arrangement f nd uses while taking all relevant factors into account. Its principal advantage e in providing the opportunity to strike a proper balance among social, conomic, and environmental considerations. Seismic safety, although but one f he factors in the land-use planning process, is nevertheless a vital one. esponsibilities for land-use planning are inherent at all levels of government and spelled out in various legislative provisions. To be effective, land-use plans st be adopted by government and supported by appropriate implementing asures.

In California, the State Office of Planning and Research (OPR) in the overnor's office is responsible for coordinating the planning effort at the State vel. This office works with other State agencies in fulfilling its planning unction. The law creating this office also assigned to it the responsibility for preparing the State's *Environmental Goals and Policy Report,* covering land use, opulation growth and distribution, urban expansion, and the conservation of atural resources. Implementation was left up to administrative and legislative tion.

The State Council on Intergovernmental Relations (CIR) is the principal coordinating office between the State and local government in California; it provides technical assistance and manages Federal financial assistance to local governments in the preparation of their general plans. Under recent legislation, it is charged with and has developed guidelines for the preparation of the mandatory elements of general plans.

On the regional level, voluntary governmental associations known as councils f governments (COG) provide regional planning guidance but they have no ect control over the constituent governments, and possess limited influence d no regulatory powers. COGs derive some power from A-95 review (review of derally funded projects to ascertain conformance with regional plans), formation dissemination, joint powers agreements, and conferences. The outhern California Association of Governments (SCAG) and the Association of y Area Governments (ABAG) are two examples of such councils. Similar ter-jurisdictional advisory planning is done by regional planning commissions ch as the Sacramento Regional Area Planning Commission.

Several special regional governmental agencies in California exercise considerable planning influence and control. These agencies, however, are the exception rather than the rule and they tend to have single-purpose concerns. e San Francisco Bay Conservation and Development Commission is perhaps most noteworthy example in the State; the newly formed California Coastal mmission is another example.

Historically, the principal planning control in California is exercised at the al (city and county) level. State planning law requires that each city and unty have a general plan, and that the general plan include certain mandatory ments. Currently, planning at regional and local levels is carried on without benefit of guidance that could be provided by a State land use policy or a velopment and conservation plan.

The State's land use planning responsibilities in connection with seism hazard areas may be seen as falling into two major categories: (1) pre-earthqua planning to prevent disasters, and (2) postquake reconstruction to avoid futu hazards.

**Planning to Prevent Disasters.** OPR is responsible for designating critic areas such as earthquake fault zones, and unstable slide areas. This has been do in broad brush fashion, approved by the Governor and mandated to Sta agencies on June 1, 1973, in OPR's *Environmental Goals and Policy Repo* OPR is also responsible for writing development guidelines for these area Seismic areas could be more closely delineated through additional studies don for example, by the U.S. Geological Survey (USGS) and the California Divisio of Mines and Geology (CDMG). These areas should then be officially declared being of statewide critical concern and a variety of mechanisms employed t implement the prevailing policies and guidelines. Among these mechanism should be: inclusion of the areas in local, regional, State, and Federal function plans; local zoning control; assignment of high priority to these areas for th acquisition of open-space programs of the State Department of Parks an Recreation, the State Fish and Game Commission, various Federal and loc agencies, and special districts; special consideration under the permit systen and zoning controls of the California Coastal Commission and the San Francisc Bay Conservation and Development Commission.

Areas of critical concern, when established by OPR, should serve as a interim guide for regional planning and administration, and should aid loc governments in the preparation of the seismic safety element of their gener plans. Review of plans and projects at the regional or State level should the determine whether there is conformity with the OPR guidelines. State guidelin should also guide the local agency formation commissions in their urban-growt determinations and all agencies in the preparation and acceptance of enviro mental impact reports. The seismic area maps should serve to control State an local development projects, and to influence all Federal programs affecting lan development. These delineations should remain in effect until a seismic progra is adopted as part of a State comprehensive plan, as described below.

**Reconstruction Planning.** It is imperative that reconstruction programs no create other disaster situations. To this end, local and State policy shoul provide that all regional, State, and Federal agencies involved in postquak reconstruction be called into the affected area immediately after a disaster t prepare and carry out an integrated reconstruction plan and program i cooperation with local and regional agencies. This should not, however, preclud the preparation of reconstruction plans prior to a disaster where geologic hazard are well defined, as discussed under Planning to Prevent Disasters above.

The reconstruction plan should delineate the responsibility and contributio of each agency, the costs for each element in the program, and the sources o funds from among public and private agencies. Responsibility for coordinatin the work of the agencies involved in preparing the emergency development pla and program could be vested in a State seismic safety commission—its regiona counterpart—or, in the absence of such a commission, in CIR. The coordinatin

ecy should bring together appropriate local, regional, State and Federal ecies to devise the working program and designate responsibilities under the cram. The integrated regional and/or local reconstruction plan should gnate the kind and intensity of uses for all land within the disaster area.

Nothing but emergency aid, public or private, should be available until the has been put together and approved.

Funding arrangements and developmental priorities with respect to areas of cal concern should be included in the plan. While control and development rvision in each part of the program should be the responsibility of the spondingly concerned agency, and while most of the working arrangements ld be handled through contracts—as is now the case—between the financing cy and the regional, local, or district agency involved, CIR, working with through regional and local governments, should be the controlling agency in disaster recovery situation.

The responsibility of CIR for maintaining a general overview of the total ect should continue to ensure that funds granted would actually produce the ts projected. The State could advance emergency planning money to be id later out of loan and grant funds.

Since these proposals simply call for refinements of existing processes, they d be instituted by executive order or, at the most, by a reorganization of ent government activities and responsibilities.

With the foregoing as the point of departure, we have attempted to propose mmendations that acknowledge an existing framework and suggest measures will help ensure adequate inclusion of seismic safety in land-use planning by ic agencies.

## ommendations

### 1. State Planning Function

California should adopt a State plan and revise existing State planning slation affecting all levels of government. It is deemed urgent that a program seismic safety in California be a meaningful and explicit part of a State prehensive plan for conservation and development devised to guide land use protect the environment.

*Discussion.* The lack of positive State policies to guide land use, and the easing number of elements that local governments must consider in general ns, have resulted in confusion of local planning efforts, misunderstanding of slative intent, and uneven conformance with State law.

Although long proposed and currently underway, the planning effort and icy statement, such as recommended above, has suffered from a lack of rest and funding, and from a low priority. Until statewide development and d-use policies are enunciated, adopted, and implemented, single-purpose State ncies and local governments will continue their unguided, segmented planning orts, which are often dictated by special-interest pressure groups and are often direct conflict with the interests of other local and regional governments and te agencies. Compliance with State requirements for mandatory and optional ments of local general plans is often half-hearted. Local government often

lacks the personnel and funding needed to develop mandatory elements, such the seismic safety element.

Highest priority should be assigned to the establishment of an ad h blue-ribbon State planning task force, composed of representatives from su bodies as: OPR, CIR, the League of California Cities, the County Supervis Association of California, the American Institute of Planners, the appropri committees of the State assembly and State senate, and the general public–t last being appointed by the Governor. The task force should be charged to the following:

a. Prepare a statewide comprehensive plan and policies that incorpora a concern for environmental problems, including seismic and other geolo hazards. Staff support for this work could be furnished by OPR, but fundi should be adequate to allow for much of the work to be completed quick through contracts with private firms. The final recommendations for a Sta comprehensive plan and policies should be ready within one year after t task force is set up.

b. Guide a statewide debate on the provisions of the plan through series of local public hearings over a six-month period. Following the hearings, the State legislature could debate, make appropriate amendmer to, and, finally, adopt the plan and policies within an additional one-ye period.

c. Develop recommendations for revising State planning legislation allow for (1) the reallocation of planning responsibility among loc regional, and State levels, and (2) the recognition, where necessary, of t State planning function in order to gain a more rational and workat system.

d. Recommend a program for consolidating planning and budgeti under the immediate direction of a successor organization that would responsible for reviewing and updating State policy as well as the progra designed to implement such policy. The activities of the ad hoc body wou be terminated at the end of a three-year period.

The basic purpose of the planning task force would thus be to prepare a help establish a comprehensive plan that would guide land and resource use California, and help to conserve and protect the environment. In developing t seismic safety features of the plan, as they relate to land-use provisions, the ta force and its staff would be dependent on the State seismic safety commissi for guidance and technical aid. The task force and its successor would be amo the State agencies meant to receive policy and program assistance from the Sta seismic safety commission.

### 2. Seismic Safety Element

The general approach to the preparation of local seismic safety elemen should be as follows:

a. Prepare and adopt a policy statement that (1) recognizes t importance of seismic hazards and their possible effects on a community, defines in general terms the acceptable (or unacceptable) level of risk wi regard to human life and economic loss, and (3) outlines a systema program to determine the existing types and levels of risk and to develop t

leans for controlling or minimizing that risk.

b. Evaluate the adequacy of existing earth-science information with egard to amount, type, availability, and relevance to evaluating risks to life nd property in the event of a major earthquake. Compile existing or readily btainable knowledge of earth processes and likely sources of information pplicable to the general plan.

c. Define both the type and extent of seismic risks involved in land-use lanning, and conditions that bear on seismic safety. For example, relate the ype and level of occupancy to the type and level of risk. Adopt long-term rograms to increase the available information where the risks appear to be reatest.

d. Formulate and adopt the seismic safety element, which should nclude:

(1) A statement of objectives that will be consistent in guiding land use in such a way as to limit seismic risk to levels acceptable to the community.

(2) A delineation—in diagram form—of areas of differing levels and types of seismic risk. This should be a dynamic document, changing as new information becomes available.

(3) A statement of policy specifying the land use appropriate to each level of risk.

(4) The modification of all elements of the general plan as necessary for consistency with the seismic safety element.

(5) Recommendations for implementation devices, such as: (a) special zoning districts for fault-hazard zones or geologic-hazard zones; (b) new ordinances, or amendments to existing ordinances, and new procedures—including abatement of existing hazardous buildings—that would mandate the review, evaluation, and restriction of construction and land use possibly subject to undue risk in areas of seismic hazard; and (c) provisions for periodic revision of the seismic safety element as new information becomes available, state-of-the-art knowledge advances, or acceptable levels of risk change.

e. Review all applications for Federal and State grants-in-aid and other orms of subsidies for consistency with the seismic safety element.

*Discussion.* CIR has been assigned the responsibility for establishing elines for all mandatory elements of the general plan. In future reviews by of the adequacy of these guidelines, it is recommended that the foregoing estions be taken into consideration.

### 3. Evaluation of Seismic Safety Progress

Legislation should be adopted to require: (a) that there be an effective ew at the regional or State level of the progress by local governments in sing, adopting, and implementing the seismic safety element of the general ; and (b) that this progress be evaluated periodically and, where appropriate, mmendations for action be submitted to the State legislature to insure that ntent is carried out.

*Discussion.* Although SB 1324, which was passed in the 1972 sessi provides for the reporting of progress by local governments in adopting a implementing land use controls for seismic safety, as well as other mandat elements of the general plan, it makes no provision for an effective review such reports or for applying corrective measures, should progress be fou wanting. It is possible that gross inconsistencies might develop betwe jurisdictions in the seismic safety measures adopted and implemented. To t extent possible, land-use controls to minimize seismic hazards should be appli equitably throughout the State.

What is needed, therefore, is legislation that would require a review of ann reports on seismic elements from cities and counties. This review could conducted by a State seismic safety commission, if created, or by CIR with t assistance of OPR, CDMG, and other appropriate State agencies. The responsil agency should coordinate all such reviews, transmit any resulting comments the city and county planning staffs concerned, and certify that each seism safety element conforms to minimum established State standards.

If, in the judgement of a reviewing agency, legislation is needed to clarify t responsibilities of local governments, or to set minimum standards f compliance with the law, the agency should propose additional legislative actic

### 4. Environmental Impact Reports

Geologic, and particularly seismic, hazards should constitute one of t environmental factors considered in the preparation of the State-requir environmental impact reports and the federally required environmental impa statements. Such factors should be specifically required in legislation a guidelines at the local, State, and Federal levels. The Environmental Quality A of 1970* required the adoption of pertinent State guidelines. These guidelin now in effect, should be amended or revised as necessary to require that proje be checked for consistency with seismic safety and safety elements of lo general plans. In addition, an environmental impact report should be requir for any proposed project that would be located in an area identified by OPR one of statewide "critical concern."

*Discussion.* While the ideal in land-use planning is to plan many ye ahead for the allocation of land uses and thereby avoid later problems, it is n always possible to do this when sites are small. Geologic, soils, and seism conditions may vary over relatively small areas. In such instances, and as further check on more general land-use decisions made at an earlier date, caref consideration of geologic problems as a part of the environmental impa reporting and review process, prior to the construction of critical structur appears to be an important link in the land-use planning and developme process.

Critical structures planned by Federal, State, and local governments, or private interests, should avoid geologic hazard areas through proper locatio Where hazardous locations must be considered, they should be selected only

* Division 13 of the Public Resources Code of California, as amended in 1972 b AB 889.

rctures can be built safely. Included in this category of critical structures ıld be buildings with high occupancies, such as high-rise buildings, theaters, n stadiums; buildings with involuntary occupancy, such as hospitals, jails, ools, asylums, rest homes, and nurseries; and structures critical to disaster very, such as highway bridges, fire stations, police stations, hospitals, and rgency centers, as well as water, power, fuel, and communications systems ities. Proposals for critical structures to be located near known, seismically e areas must be judged during the plan-review stage for the degree of seismic s involved and precautions designed to mitigate risks.

The Governor's *Environmental Goals and Policy Report* states that the owing, rated on a priority scale, are potential areas of "critical concern": e areas identified in the *Urban Geology Master Plan for California,* ifically those involving hazards of earthquake shaking, flooding, volcanic tions, tsunamis (seismic seawaves), fault displacement, landslides, subsid-, erosion activity, and expansive soil.*

Development or construction plans in any such area should be requried to ude an environmental impact report that considers the hazards and proposes able mitigation measures.

### 5. Local Agency Formation Commissions

Each Local Agency Formation Commission (LAFCO) should be re-ed—through amendment to State code sections 54790 and 56250—to sider seismic safety factors in its deliberations and decisions.

*Discussion.* LAFCO is a State agency in each county created to oversee incorporation of new cities, the development of new communities and cial districts, the annexation or exclusion of territory by these entities, and r dissolution. These commissions have the power to approve or disapprove n proposals wholly, partially, or conditionally. Some LAFCOs have inter-ed their enabling legislation to limit their authority to a consideration of ernment structure and organization. Consideration of seismic and other l-use planning factors by LAFCOs should be specified in greater detail in the bling legislation.

### 6. Fault Hazard Control

The Alquist-Priolo Geologic Hazard Zones Act should be amended to and its scope and to clarify certain parts for better implementation.†

*Discussion.* Passage of the above act, also known as SB 520 (1972), ieved two very important and long-needed objectives: (1) assumption of te responsibility for mapping active fault zones, such mapping to help in king land-use decisions, and (2) establishment of State policy and criteria for

ee the Governor's *Environmental Goals and Policy Report,* 1973, Appendix, .4.

ee "Supplement on Fault Hazard Control" for more details and a fuller iscussion.

regulating land use along active faults. However, drafting the bill to meet t legislative deadline did not allow sufficient time to study details of implemen tion of the act. The following recommendations are offered to amend the a and to correct inadequacies:*

a. The act should be expanded to include all other geologic hazards addition to active-fault hazards, or, alternatively, the title should be chang to "Alquist-Priolo *Fault* Hazard Zones Act."

b. It seems desirable to reassign State responsibility for setting land-u policies and criteria from the State Mining and Geology Board to a Sta seismic safety commission or to OPR.

c. The responsibilities of the State Mining and Geology Board and the State Geologist should be clarified.

d. The collection and assignment of fees should be made clearer.

e. The requirements for, and review of, technical reports in support construction and development applications should be clarifed.

f. Provisions for land-use controls should be extended to cover Sta and Federal projects as well as those of local government and the priva sector.

### 7. Flood-Plain Management

The Safety of Dams Act should be amended to make land-use plannin and regulation of flood-plains a condition for local, State, Federal, or privat construction of dams. To help achieve maximum safety and operating efficienc for any dam project, the State water law should be amended to direct loc districts and the State to integrate feasibility and engineering studies in th planning and operation of dam structures with plans for flood-plain manag ment.

*Discussion.* For water-retaining structures in areas of seismic hazards control of flood-plain development should be part of the reservoir o flood-control plan, and its cost worked into a total project-development cost The purchase of all potential flood plains, or a combination of purchase an zoning could be a satisfactory alternative to costly levees, bypasses, an additional dams. Quantifiable benefits, in terms of open space, parks, agricul ture, and other recreational uses, in economic evaluations would present viabl alternatives to strictly structural approaches.

The Federal Government—through the Corps of Engineers and the Bureau o Reclamation—recommends local flood-plain zoning and has refused to put u flood-control structures in the absence of an integrated management program Federal agencies currently refuse to move into planning and authorizatio without zoning commitments by local governments. The State Department o Water Resources, under present law, requires local governments to enac ordinances controlling development in flood plains as a condition for Stat reimbursement for the costs of land and rights-of-way on Corps of Engineer projects. Storage reservoirs of the State and of local districts are under th supervision of the California Division of Safety of Dams.

* See "Supplement on Fault Hazard Control" for more details and a fulle discussion.

8. **Information Function of Government**

A program should be developed to help meet the joint needs of regional and local governments for seismic information in land-use planning and regulation. This should be done by the State seismic safety commission, or by OPR with the assistance of CDMG and USGS.

At regional and local government levels, public hearings on the seismic safety element of general plans should be used to inform the general public about the seismic characteristics of land in the jurisdiction, and about policies needed to minimize the threat to life and property.

*Discussion.* The main objectives of this program should be (1) to develop information and guidelines that local governments need in order to satisfactorily apply seismic-geologic data in land-use planning, and (2) to identify for regional agencies geographic areas requiring additional data on a high-priority basis.

The following information needs clearly exist:

a. Agencies producing seismic-geologic data need financial support and guidance in establishing priorities. Such data should be translated into a form useful for urban land-use planning; special consideration needs to be given to the format, scale, and accuracy of such data.

b. For purposes of land-use planning, seismic-geologic information must be presented in a form to facilitate decision-making concerning hazards to life and property, environmental degradation, and, in general terms, construction and maintenance costs.

c. Regional and local governments need technical assistance in order to properly consider seismic factors in the preparation of general plans. Information is needed to resolve problems connected with: (1) the relationship between seismic, socio-economic, and urban physical data; (2) data storage and retrieval; and (3) the preparation of cost-benefit analyses.

d. Regional and local governments need assistance in developing comprehensive plan-implementation programs. Such assistance should include help in identifying data gaps, in specifying technical requirements to be met by public and private land developers, in streamlining administrative procedures, and in devising new and alternative legal tools necessary to guide and regulate land development.

## ZONING REGULATIONS

### Background

Zoning enabling legislation is set forth in Chapter 4, Title 7, of t Government Code. These relatively brief provisions prescribe in broad ter what can be accomplished under zoning. In Section 65850 of Chapter 4, the l states that zoning may be used to implement a general plan, and imposes *minimum of limitation* so that cities and counties may exercise a maximu degree of control over local zoning matters. Section 65853 exempts chart cities from the provisions of Chapter 4.

Section 65860(a) of the Government Code has been amended to require th as of January 1, 1974, the zoning ordinances of local jurisdictions be conformity with their adopted general plans. The amendment provides a mu needed statement relating zoning regulations to general plans. Furthermore, wi the existence of the newly adopted provisions making the seismic safety eleme a mandatory component in city and county general plans, zoning ordinances f general-law cities should now also be tailored to implement seismic safe policies.

### Recommendations

#### 1. Zoning by Charter Cities

Section 65860(a) of the Government Code should be amended to requi that the zoning regulations of charter cities be consistent with their gener plans.

*Discussion.* The importance of the seismic safety element is such that t element ought to be an intergral part of all city zoning regulations. At this tim there is no requirement that charter cities relate their zoning practices to t seismic safety element.

#### 2. Enabling Legislation

The State planning law, Section 65800 et seq (Zoning Regulations) an Section 65450 et seq (Specific Plans) of the Government Code, should b amended to indicate clearly that zoning and "specific plans" may be based o the need to protect property from floods, earthquakes, and other such natur hazards.

*Discussion.* This kind of justification is implied in the planning law written, but there is a need to make it explicit and thus remove any ambiguity to legislative intent. This would encourage local use of the provision and bolst the position, in this regard, of legal and planning advisors to the cities an counties.

## SUBDIVISION REGULATIONS

### Background

The process whereby local government allows land to be divided and sold in separate pieces under the supervision of the State is one of the most critical steps in urban development. All cities and counties, including those set up by charter, are required to adopt subdivision regulations. Experience has indicated that once land has been divided, the resulting parcels will come under great pressure for development without regard to the appropriateness of such development in terms of terrain limitations (including seismic problems). It is, therefore, very important that land planned for development be carefully analyzed with respect to seismic hazards at the earliest possible stage in order to determine its suitability for subdivision. Mistakes made in the subdivision process are virtually impossible to correct other than through redevelopment—an expensive method of correcting past errors.

The following provisions in the Business and Professions Code of California govern the subdivision and sale of land:

**Subdivision Map Act.** Administered by local jurisdictions, this statute concerns basically the procedure and requirements for recording subdivision maps, lot design, and physical improvements associated with the creation of lots.

**Subdivided Land Law.** Administered by the State Real Estate Commissioner, this law establishes procedures and requirements for offering lands and new subdivisions for sale or lease. Its primary purpose is to protect purchasers of land in new subdivisions from fraud, misrepresentation, or deceit.

Amendments are needed to the Subdivision Map Act, Subdivided Lands Law, and the Health and Safety Code to insure that cities and counties adopt and follow good practices in setting requirements for geologic investigations. The amendments should make particular reference to seismic problems. Previous amendments to the Health and Safety Code relating to soils reports have been effective in seeing that the public interest is protected by local jurisdictions.

### Recommendations

**1. Definition of Subdivision**

Chapter 2 of the Subdivision Map Act should be amended to redefine "subdivision" as any division of land into two or more parcels.

*Discussion.* Such an amendment would extend the act's requirements for soils and geologic reports to all divisions of land. Serious mistakes can be made even in dividing one piece of land into two parcels. For instance, it is entirely possible in such a case that geologic or seismic hazards would make structures virtually unbuildable on one of the parcels. To simplify procedures, small subdivisions resulting in less than five parcels should be subject to abbreviated reviews where possible, and parcel maps should be permitted for such divisions in lieu of final subdivision maps where appropriate.

2. **Soils and Geologic Investigations**

The Real Estate Practices Act, the Subdivision Map Act, and the Healt and Safety Code should be amended to require geologic-seismic and soils repor on all subdivisions unless the requirement in a given case is waived by registered soils engineer and a registered geologist certified in engineerir geology, both acting on behalf of the local jurisdiction. The content of suc reports should conform to minimal requirements set forth by CDMG, the Sta seismic safety commission or other appropriate State agency. The reports shoul be prepared by (1) registered civil engineers specializing in soils engineering, an (2) registered geologists certified in engineering geology. This recommendatic should receive the highest priority. Amendment of the Map Act, Health Cod and Real Estate Practices would, accordingly, supplement the requirements s forth under the Geologic Hazard Zones Act.

*Discussion.* Urbanization is highly dependent upon strict econom considerations, a factor which has often inhibited the application of prope geologic-seismic safeguards. This has been true even in some communities whic have taken the leadership in administering restrictions on land development i geologically and seismically hazardous areas.

Legislation resulting from this recommendation should not be enabling i nature, but it should be mandatory. The administration of local requirements fc geologic-seismic reports (within standards specified by the State) would remai with the local governments as part of this recommended legislation. Implemen tation by legislative action should proceed in the immediate and futur legislative sessions.

3. **Approval of Subdivisions**

a. The Real Estate Practices Act should be amended to require that (1 the Real Estate Commissioner, upon the advice of CDMG or the loc governing agency, deny issuance of a Real Estate report where there i reasonable doubt about the safety of a subdivision with respect t geologic-seismic hazards, and (2) the local agency advise the Real Estat Commissioner regarding any geologic problems on subdivision lots and th need for further geologic investigation of such lots which is discovered afte the preliminary grading for access roads of an approved subdivision has bee completed. Basic geologic problems are often discovered after such grading i completed. Currently, such notification is only permissive in nature.

b. The Subdivision Map act should be amended to require that citie and counties deny subdivision approval whenever there is reasonable doub about the geologic-seismic safety of individual lots or subdivisions.

c. Guidelines defining reasonable doubt with respect to geologic-seismi safety should be provided as part of the Subdivision Map Act. Thes guidelines might well be patterned after those recommended by professiona organizations such as the Association of Engineering Geologists. They shoul be compatible with any future geologic-seismic guidelines for controllin zoning in compliance with adopted general plans, and with policies an criteria cited by the Geologic Hazard Zones Act.

*Discussion.* The above measures are urgently needed. Residential elopment of geologically hazardous land increases every year. For example, division and single-lot construction continues within the San Andreas Fault e, without any or, at best, with minimum geologic-seismic control. Some al agencies, moreover, approve development of new subdivisions after only imal demonstration of the project's seismic safety. Thus, the feasibility of d development from the point of view of geologic-seismic hazards at times is adequately established before the local planning agency approves such elopment.

Although geologic-seismic controls should be implemented at the local level, ndardized minimum guidelines should apply statewide through the Subision Map Act and the Real Estate Practices Act.

**4. Certification of Final Maps**

The Subdivision Map Act should be amended to provide for the owing:

a. Any soil and geologic investigations made with respect to a subdivision should be noted on the face of the final subdivision or parcel map, and the geologist, soils engineer, and supervising civil engineer preparing the investigation and final map should certify that this has been done in conformance both with good professional practice and with applicable guidelines—the latter to be set forth by CDMG or some other designated body.

In addition, the engineer and geologist reviewing such investigations for a city or county should also certify that the investigations comply with minimal State guidelines, policies, and criteria.

b. Consulting geologists and soils engineers should certify final subdivision maps, clearly indicating where geologically hazardous areas remain, even though the planned subdivision has been approved. These areas should be noted on the recorded map as "geologically hazardous areas" and the city or county involved should have the right to restrict the erection of permanent structures within such areas. Once the areas are marked on the map, the local building and safety official should be notified and building permits for such areas should be denied until such time as the hazard is removed. (This would probably also require amendments to the Health and Safety Code.)

c. Local agencies that do not have the appropriate staff to review geologic reports submitted in support of subdivision applications should be encouraged to develop the necessary assistance as detailed in recommendation 1 under "Geotechnical Assistance for Local Governments."

*Discussion.* As previously recommended, the Subdivision Map Act should uire that the local planning agency disapprove a final subdivision map, or the ected portion of a final map showing geologic-seismic hazards, and, where propriate, require that specified protective improvements be constructed as a ndition of approval. In addition, any geologic hazard discovered should be ted on the final map and the erection of permanent structures thereon

restricted subject to the approval of the local Department of Building and Safety or its equivalent in each city or county.

A review agency is needed for certification of final maps. Local agencies should be encouraged to provide review by their own staffs or refer to their consultants for technical support. Where local agencies do not have such review capacity, the State should consider alternative actions to insure competent review of geologic-seismic reports submitted by developers in support of final map certification. This service could be funded through a fee charged to the developer.

## BUILDING, GRADING, AND THE SALE OF PROPERTY

### ackground

Building and grading regulations, and the recently State-authorized residen- property reports are vital controls in helping to assure seismic safety at the ect execution stage. The broader land use policies of city and county general ls may become meaningless if these final-stage regulations are not carefully lemented.

Cities adopt building codes as they wish, except for certain minimum dards required by State law such as the Housing Code, the Riley Act, the d Act, and applicable provisions of the Health and Safety Code. The codes pted are usually modifications of the Uniform Building Code (UBC) ored by the International Conference of Building Officials; they generally vide minimum protection against geologic-seismic hazards. The UBC covers y facets of construction including earthquake resistant structural design, ndation conditions (Chapter 29), and grading (Chapter 70). The design of hquake-resistant structures lies more within the expertise of the Advisory up on Engineering Considerations and Earthquake Sciences and is therefore discussed in this report. The question of foundation conditions as related to tion and the matter of grading, however, is more directly pertinent to land considerations and is therefore dealt with here.

Local governments are now authorized by State law to require that dential property reports, indicating property conditions, be furnished to chasers of property prior to consummation of a sale. To insure that seismic other geologic problems are considered in such reports and that the reports required, some amendments to the State law are needed.

### ommendations

**1. Building and Grading Regulations**

State legislation should be enacted stipulating the following:

a. Local governments must adopt the Uniform Building Code (UBC), revised to: (1) require soils-geologic reports that assess the seismic stability of foundations for building permits for which grading is not required (Chapter 29), unless waived by engineers and geologists employed by local government; (2) require soils-geologic reports that assess the seismic stability of critical slopes developed under grading regulations (Chapter 70), unless waived by engineers and geologists employed by local government; and (3) prohibit the construction of buildings for human occupancy directly over an active fault trace as specified by the local governmental agency under definitions set forth by the State.

b. Local governments must have all applications for building and grading permits reviewed by a competent engineering geologist to determine if soils-geologic reports are needed, and they must also review such reports for adequacy.

*Discussion.* The recommended updating of the UBC would prohibit the uance of a building or grading permit if the local building official, on the

advice of a geologist, found that approval would have an adverse impact c property outside a given site as well as on the site itself. Local buildir ordinances should, moreover, take cognizance of geologic hazards other tha seismic, such as landslides or settlement, in regulating the issuance of building c grading permits on affected sites.

The requirements for a geologic review of building and grading permits coul be simplified in a number of ways. For instance, on the basis of an adequat engineering-geologic map that indicates areas least likely to have significar foundation problems, a locality could waive the geologic review requirement fc each permit in such areas. However, all reports submitted on behalf c applicants for permits should be reviewed for adequancy by a qualified geologis responsible to the local government; the cost of such a review could be charge to the applicant. The availability of qualified geologists for such reviews recognized as a problem and is discussed in the next major section of this repor

These recommendations pertain to the UBC because it is the single mo widely used code. Our concern, however, is only with respect to those portion of the code dealing with seismic safety and other geologic hazards. In makin our recommendations, we do not intend to endorse all parts of the UBC. It als seems to us that local governments should be allowed to adopt more stringer code provisions if they so desire.

### 2. Property Reports

The State provision allowing cities and counties to require propert reports prior to the transfer of properties should be made mandatory, and i should also apply to the resale of vacant properties and to properties witl nonresidential structures as well as to the currently specified residentiall developed properties. Furthermore, the law should specify, among othe matters, that where official city or county information on geologic and seismi conditions pertaining to the site exists, that information should be noted in th residential property report.

*Discussion.* State law (commencing with Section 38780 of the Goverr ment Code) now permits local jurisdictions to require that a seller of propert obtain a residential property report from the city or county prior to the *resale* o a residence. The law does not cover the first sale of residences in a subdivisio approved by the Real Estate Commissioner, nor does it pertain to the resale o vacant lots or of property with structures for nonresidential use. The purpose o the law is to make certain that purchasers are aware of local regulations an special restrictions pertaining to a residence and land parcel prior to th consummation of a sale. The proposed amendments would make this law muc more effective as a protection for unwary buyers.

## GEOTECHNICAL ASSISTANCE FOR LOCAL GOVERNMENTS

### kground

More and more jurisdictions throughout California are requiring that e ogic and other technical reports accompany applications for a variety of cstruction projects, development proposals, and requests for rezoning. The ee to which such reports and their recommendations may meet the intent of governing body depends largely on the extent to which the reports are ewed and scrutinized by a qualified staff member of the jurisdiction. In the nce of adequate technical review, the client/developer serves as the sole (and n biased) judge of the scope, direction, and adequacy of the technical study ertaken.

Additionally, homeowners and applicants for permits complain that geologic sultants are not available to prepare such reports, or that they are too costly. s seems to occur wherever soils engineers and engineering geologists are jected to frequent liability suits in carrying out their professional roles. The ility risk has become so great in some areas that many professionals and most ns no longer accept work to evaluate single lots or, in many cases, even divisions. In other areas, professionals have increased their fees to provide -insurance. Both conditions effectively deny the needed expertise to those king advice, and result in widespread public losses.

### ommendations

**1. Obtaining Geologic and Engineering Assistance**

Local governments in California should be urged and encouraged to add ertise on engineering geology, as well as on soil and structural engineering, to ir staffs in order to help guide planning and capital improvement programs l to insure effective compliance with regulations that require geologic and ineering reports. If, after a reasonable length of time, local governments have staffed or contracted to fill this need adequately, the legislature should nsider steps to require qualified technical review by cities and counties, or to nsfer that function to State or regional governmental bodies.

*Discussion.* This goal may be accomplished by several means, depending the size of the jurisdiction involved, the development pressures it faces, and complexity of the geotechnical problems it must deal with.

Ideally, local jurisdictions would employ geologists and engineers directly as t of their staffs to function effectively as: (1) consultant to the planning staff the preparation of components of the general plan, such as the seismic safety, ety and conservation elements, and in developing implementing ordinances d regulations; (2) advisor to the Department of Public Works on proposed new nstruction under capital improvement programs and on the maintenance of isting structures and roads; and (3) reviewer of geologic and engineering orts submitted in compliance with zoning, subdivision, and building ulations.

Alternatively, jurisdictions might contract with a higher-level government dy, with nearby government bodies at the same level, or with private

consultants for the geologic and engineering review service. Even relatively sma jurisdictions may be served by a sizable qualified geotechnical staff if combination of geotechnical problems, combined with developmental pressure warrants amalgamation of the review function by a number of governmental unit at the county, subregional, or regional level. Economic constraints an possibilities of conflict of interest limit the maximum effective use of privat consultants.

A variation of the above solution would be to constitute technical assistanc boards, with a geologic and engineering review capability, as the regional arm o a State seismic safety commission. Such regional boards should consist of highl qualified personnel and should provide local governments with engineering an geologic assistance as an aid in implementing State-mandated policies. Suc assistance should be available at all stages of the planning and implementatio process, as well as to aid in the solution of a wide range of geotechnical problem beyond the scope of seismic safety.

Local governments should be encouraged to levy fees on building subdivision, and rezoning applications to meet the cost of geotechnical review o land use proposals. Should local government fail to provide for effective revie of required geotechnical reports, the legislature should consider other actions t accomplish this necessary function. Possible solutions might range fro requiring that local governments hire qualified geologic and engineering staf members, to transferring the geotechnical review function to county, regional, o State levels.

### 2. Protection of Geologists and Other Professionals and Technicians

Legislation should be enacted to provide reasonable liability protectio for geologists, civil engineers (including soils engineers), and other geotechnica consultants, whose services are indispensable to a program of protection agains earth hazards.

*Discussion.* Specifically, legislation to alleviate the problem of liabilit might include one or more of the following alternatives:

a. Reaffirm exemption of such practitioners from strict liability unde principles being developed by California courts at the present time.* In th absence of preventive legislation, such persons may be held liable as insurer against defects regardless of reasonable care and prudence taken in th performance of their duties.

b. Make it clear that the applicable statute of limitations runs from th time of performance of duties by such persons rather than from the date o discovery of any defect or the development of earth failures resulting fro such a defect. Under existing law, the relevant statute of limitations may no

* See, for example, *Avner vs. Longridge Estates,* 272 C.A. 2d 607, 77 Cal. Rptr. 633 (1969), holding that a cause of action exists by a homeowner against a tract developer on a theory of strict liability—without fault—for hidden soils defect. See also *Kriegler vs. Eichler Homes, Inc.,* 269 C.A. 2d 224, 74 Cal. Rptr. 749 (1969).

ommence running until many years after the geologist or engineer has ompleted his work. Under these circumstances it is very difficult to do dequate risk planning or to maintain appropriate insurance to cover the npredictable exposures to law suits.*

c. Amend the California Tort Claims Act, where necessary, in order to ssure that outside geotechnical consultants who render services to public mployees are protected to the same degree as public employees. It is likely hat under existing law, geologists, soils engineers, and other professionals vho act as independent contractors with cities, counties, and other agencies ave no special immunities, privileges, or rights to indemnity or to be rovided counsel, as do other public employees under the Tort Claims Act. Many professionals may thus be deterred from rendering the same services or endering the same advice as would regular employees.

d. Provide a program of professional-malpractice insurance where rivate insurers fail to provide reasonable coverage. At the present time, nany geologists and soils engineers refuse to render services to private omeowners or smaller developers because of increasing liability judgements gainst them and because of the unavailability of suitable insurance, which, ombined with the normally small fees for such services, creates an nacceptable risk for the professional. In the event that geotechnical rofessionals are unable to obtain sufficient insurance, it may be necessary or the State to create a malpractice insurance program similar to workmen's ompensation.

e, for example, Code of Civil Procedure Section 337.15 (10 year limitation certain actions against developers, engineers, etc.)

# ADDITIONAL MEASURES

## Background

There are a number of mechanisms for guiding land use besides such traditional and basic ones as the general plan and the zoning, subdivision, building, and grading regulations. Generally speaking, major land use changes are in some way brought about by Federal or State subsidies, grants for local actions, or the underwriting of private development. For this reason, it is appropriate that these mechanisms be examined and, where necessary, modified to insure that they reflect adequate seismic safety policies.

## Recommendations

### 1. Dealing with Hazardous Structures

Local land-use regulations should provide for the eventual removal of existing structures not in conformity with seismic safety policy.

*Discussion.* As fault-hazard and other seismic land-use regulations are adopted, cities and counties will have to devise policies to deal with existing structures that do not comply with the applicable standards. It is usually difficult to establish the extent of any seismic hazard with a high degree of certainty; that is, to predict when an earthquake will occur and which structures in a given area would be destroyed or seriously damaged. A policy for dealing with existing, noncomplying structures might call for the rapid amortization and removal of those that constitute the greatest hazard to the most people (e.g., high-occupancy buildings and critical structures), while hazardous structures endangering fewer people might be permitted to remain for a longer time. A minimal legal requirement would be to have apparently less hazardous structures evaluated by the local jurisdiction to determine whether there is a real need for their removal. If the owner of a building objects to an order for its removal, he could obtain an independent professional opinion from an engineering geologist or structural engineer, depending upon whether the hazard relates to poor foundation conditions or to structural inadequacies. The report should evaluate the site and/or structure and certify that the structure is reasonably free of seismic hazard, if this proves to be the case. Such a report, of course, should meet with the approval of the local jurisdiction through a proper review of its adequacy.

Thus, hazardous buildings of critical use or of high occupancy should not be tolerated for any length of time while less critical structures might be permitted longer periods for amortization prior to removal.

### 2. Utilizing Urban Renewal

Sections 33020 – 33022 of the California Health and Safety Code (Community Redevelopment Law) that define areas eligible for urban renewal should be amended to include areas with existing seismic hazards or where disasters have occurred. The revision should provide for clearing hazard areas for open-space use, relocating residents to an area of low seismic risk, and where feasible, reconstructing the area with properly designed buildings.

*Discussion.* This amendment would encourage the use of the urban
wal program to make land use and structures compatible with seismic safety
iderations. It would provide for either of two courses: (1) the land in
tion could be converted to open space or some other low-intensity land use,
2) if consistent with seismic safety, existing structures could be rebuilt to
opriate standards.

**3. Use of Federal Funding Programs**

Approval of applications for all Federal grant and loan programs and the
nue sharing program should be contingent upon a demonstration by the
icant that the proposed development or land use is compatible with seismic
y considerations. If State or local policies are in effect, they should be used
uidelines. If no State or local policies exist, Federal policies concerning
nic safety requirements should be developed and applied.
Federal grant programs such as new-town funding should not be used to
pound problems by encouraging development in areas of high seismic
rd, but rather to establish such developments in low risk areas with
opriate construction standards.
FHA and HUD certification and underwriting programs should not be
ied to high-seismic-risk zones.
High priority should be given in federally subsidized housing programs to the
cation of residents from structures in areas of high seismic risk, and in need
newal, to areas of low seismic risk.

*Discussion.* As of this time there is no provision for the consideration of
nic problems in the selection of new-town sites. There is, therefore, the real
ibility of Federal funds being expended to subsidize high-cost, special
neering solutions for new development or redevelopment in areas of high
nic risk. Such funds would be more wisely and effectively spent for
lopment in low risk areas.

## SUPPLEMENT ON FAULT HAZARD CONTROL

The Geologic Hazard Zones Act (SB 520) was signed into law by t Governor on December 22, 1972. This measure marks a major forward step limiting damage from one type of seismic hazard—ground rupture from faultir The following discussion presents some detailed recommendations for amendi the act and the rationale behind them.

### Recommendations

To help advance the goals of public safety, it is strongly recommended th the Alquist-Priolo Geologic Hazard Zones Act be amended as follows:

1. The act should be expanded to cover the broader category of geolo hazards, rather than just those due to active faults.* Alternatively, the title the act should be changed to "Alquist-Priolo *Fault* Hazard Zones Act," to refle more clearly the content of the legislation.

2. It should provide for adequate annual funding to cover the maintenan of maps of special studies zones, and for new studies of possibly active faults.

3. It should prohibit the building of structures for human occupancy or f public service facilities (e.g., highways, dams, bridges, and utilities) on *an act fault trace,* or where an undue hazard would be created, except where it shall deemed essential to do so for the public welfare.

4. It should require that all actions to *zone or subdivide land,* applications for permits to build structures intended for human occupancy, a all proposals for *public service facilities* anywhere within a special studies zo shall be reviewed and approved by the appropriate agencies of local regio governments.

5. It should require that approval by the local planning commission, c council, county board of supervisors, or regional governing body of any of t items specified in 4 above be contingent upon: (a) the submission by t applicant of geologic reports directed to the problems of potential surfa faulting and deformation and of ground failure caused by seismic shaking;† ( the review of the required geologic and engineering reports by geologic a engineering personnel acting on behalf of the jurisdiction; (c) the determinati that an undue geologic hazard would not result from the zoning, subdivision lands, or construction; and (d) the determination that the proposal is consiste with the seismic safety element and other provisions of the general plan and implementing ordinances, if any.

6. It should require the approval outlined in 5 above for all repairs reconstruction of existing structures and facilities, as defined in 4, that in a one year exceed 50 percent of the market value of the structure or facility.

7. It should transfer the responsibility for establishing land use policies a criteria which cities and counties may use in approving real estate developme

* Specifying the legislative details needed for this amendment is beyond t scope of this report.

† Reports may be waived by the jurisdiction upon the recommendation of registered engineering geologist acting on behalf of the jurisdiction.

n structures for human occupancy from the State Mining and Geology Board OPR, or to a State seismic safety commission should such a body be blished. It should provide for geologic and planning guidance and technical stance to local governments through a State seismic safety commission and egional components.

8. It should require that all capital improvement projects proposed by State local governments be subject to the same review and approval procedures as required in the case of private developers.

9. It should memorialize the U.S. Congress to require that all Federal ects proposed within special studies zones and along active fault traces be nitted for review and approval as specified in 8 above.

10. It should: (a) delete reference to the establishment of fee schedules by State Mining and Geology Board; (b) repeal the requirement that one-half of proceeds from fees collected by local government shall be deposited in the e General Fund; and (c) allow for the collection and assignment of fees from applicant within designated active fault zones (special studies zones) to pensate for the cost of review and administration of the controls required by legislation, all of which will be borne by local government (either directly or ough contract with private consultants or with regional technical boards).

## ussion

As mentioned earlier in this report, passage of SB 520 achieved several very rable objectives: (1) recognition of State responsibility for mapping active t zones with regard to land use decisions, and (2) establishing State policy criteria regulating land use along active faults. But the limited time available drafting the bill did not provide an adequate chance to study the details and blems of its implementation. Consequently, the act has some shortcomings t warrant correction through amendments as follows:

1. As adopted, the Alquist-Priolo Geologic Hazard Zones Act pertains solely ault hazards and does not cover the much broader problems imposed by all logic hazards (landslides, volcanism, erosion, expansive soils, etc.). Expansion he act to include statewide geologic conditions that impose severe constraints development is highly desirable, but working out the legislative amendment ded to accomplish this was considered to be beyond the scope of our study. ring such an expansion, the act should be retitled as recommended so as not e misleading.

2. There is a need to reexamine State responsiblity for setting land use icies and criteria. Although the State Mining and Geology Board is eminently l qualified to evaluate the geologic factors affecting land use, translation of se conditions into land use policy and criteria requires more planning ertise than is provided by the addition of a single planner to the board. Nor is lesirable to broaden the scope of an already overworked board that was situted for an altogether different purpose. It does seem appropriate, on the er hand, to assign such responsibilities to a broadly based State seismic safety nmission, if one is formed. Such a commission would have to deal with a iety of related land use questions, all pertaining to seismic safety. In the rim, this function should be performed by OPR.

3. Certain responsibilities of the State Mining and Geology Board and the State Geologist remain ambiguous. Section 660 of the Public Resources Code was amended to define the State Mining and Geology Board as a policy and appeals board for purposes of the Hazard Zones Act. Yet none of the responsibilities of the board specified by the act involves appeals. Consider the following:

a. Section 2722 states that affected cities and counties may submit comments on special studies zones maps and their revisions to the board. It does not specify what the board is to do with these comments other than to consider them. It does not state the agency, board, or officer responsible for certifying the maps as official, nor does it provide for any appeal of this decision.

b. Section 2623 provides that cities and counties shall approve buildings in accordance with policies and criteria established by the board, but does not provide for revision or appeal of those policies and criteria.

c. Section 2625 requires that the board establish a schedule of fees to be charged each applicant for a building permit within a special studies zone but, again, with no provision for appeal of the level of fees charged.

4. The act contains ambiguity and inequity with regard to the fee schedule. Section 2625 specifies that the fees shall (a) not exceed the costs to State and local governments of administering the provisions of chapter 7.5, (b) not exceed one-tenth of one percent of the total valuation of the proposed construction and (c) be divided equally between the local jurisdictions and the State.

The difficulties connected with the way in which this section of the act is drawn are as follows:

a. No review or fees are required of applicants upon the submission of requests for rezoning or for approval of land division—the time when decisions limiting land use should be made.

b. The specified division of fees between the State and the cities and counties is arbitrary and likely to be inequitable. No provisions are made for compensating local governments if their costs exceed those of the State. For example, the cost to a local government could well exceed 50 percent of the maximum allowable fee, while the State's costs could be less than 10 percent (on a statewide basis). Cities already funding the cost of geologic review from fees they charge developers might suffer from passage of the act and could end up with a lessened capacity for performing these reviews.

c. Although section 2624 of the act states that cities and counties may impose and collect fees in addition to those required under chapter 7.5, it remains questionable whether such additional fees could be applied to the administration of this chapter because of the limitations imposed in section 2625.

d. It is questionable whether a geographically limited number of applicants can or should be charged fees to compensate the State for work which may not be done because there is no assurance that the legislature will appropriate the necessary funds.

e. Finally, the bulk of the State's costs in administering and complying with the provisions of chapter 7.5 will occur in the first year and a half, and these costs are covered largely by the appropriation of $100,000 (section 5)

In subsequent years, the State's role will be limited to the revision of maps of special studies zones, which should be a part of its basic, ongoing program and should not act to siphon funds that may be badly needed by local governments for performing geologic reviews. For example, the designation of active faults is a part of the regular program of CDMG and should be funded directly by the legislature.

5. The act is also somewhat ambiguous with regard to certain requirements r geologic and engineering studies. Section 2624 prohibits approval of "the cation of such a development or structure if an undue hazard would be eated, and approval may be withheld pending geologic and engineering udies . . . . If the city or county finds that no undue hazard exists, geologic and gineering studies may be waived, with the approval of the State Geologist." his provision should be revised to require geologic reports for all proposed velopment and construction within active fault zones and over active fault ices unless waived by the local jurisdiction upon the advice of a registered ologist acting on its behalf. Cities and counties have little basis on which to dge whether an undue hazard exists until *after* the studies have been made, less their geologic advisors—after detailed reviews of similar geologic reports om adjacent properties—have adequately defined the areas without active fault ices. The requirement that the State Geologist approve the waiving of geologic d engineering studies for each applicant in special studies zones throughout e State could easily constitute an administrative bottleneck that would riously hamper the implementation of chapter 7.5. In addition, it places undue al authority at the State level where local jurisdictions have an equal or eater geologic capability in making judgments on waivers.

6. Last, but not least, the act should (a) require that the State—in its erations—adhere to the seismic safety policies applied to the public and to cal governments, and (b) urge the Federal Government to conform with at ast the minimum applicable safety standards.

# Report of the Advisory Group on Governmental Organization and Performance

# ADVISORY GROUP ON GOVERNMENTAL ORGANIZATION AND PERFORMANCE

James Algie
Assistant City Manager
City of Burbank
1970 - 1971*

W. Richard Bigger
School of Public Admin. and Urban Studies
San Diego State University
1970 - 1974

Thomas J. Blanchard
Chief Deputy City Attorney
City of San Francisco
1970 - 1971

Heinz Eulau
Chairman, Department of Political Science
Stanford University
1970 - 1971

Bernard J. Favaro
Favaro & Lauezzo
Attorneys at Law
1970 - 1971

John D. Flitner
City Attorney
City of Santa Rosa
1971 - 1974

Louise P. Giersch
City Councilwoman
City of Antioch
1970 - 1974

Mary W. Henderson
Vice Mayor
City of Redwood City
1970 - 1974

Martha B. Hopkins
Geologist
1970 - 1974

Joseph Houghteling
Commissioner
S.F. Bay Conservation and Development Comm.
1972

Marcella Jacobson, *Chairman*
Commissioner
S.F. Bay Conservation and Developmen
1970 - 1974

Walter T. Johnson, Jr.
Emergency Planning Coordinator
Southern California Gas Company
1970 - 1974

Edward P. Joyce
Director
Emergency Services of San Francisco
1970 - 1974

Robert Levy
City Engineer
City of San Francisco
1970 - 1974

Melville Owen
Commissioner
S.F. Bay Conservation and Developmen
1970 - 1971

Richard Pantell
Professor of Electrical Engineering
Stanford University
1971 - 1974

Robert Rigney, *Vice Chairman*
Admin., Environmental Improvement A
County of San Bernardino
1970 - 1974

Richard W. Roether
Planning Consultant
Eugene D. Wheeler & Associates, Inc.
1971 - 1974

Stanley Scott, *Vice Chairman*
Asst. Dir., Institute of Governmental St
University of California, Berkeley
1970-1974

Graham O. Smith
City of Los Angeles
1971 - 1974

*Dates of service

## INTRODUCTION

After considering the charge from the legislature, the Advisory Group on vernmental Organization and Performance set for itself the following ectives:

1. To identify areas of inadequate or questionable governmental perform- e in the field of seismic safety, and to develop criteria and proposals for provements.
2. To study special problem areas of governmental organization, enforce- nt, and performance, such as mutual aid, land use control, financing and tax rm, and liaison between governmental agencies; to gather and analyze rmation on existing seismic regulations, procedures, and accomplishments at evels of government.
3. To consider the legal, financial, and organizational reforms that may be ired to improve seismic safety.
4. To determine which governmental agencies can best provide certain cified services.
5. To evaluate seismic safety considerations that should serve as the basis for ffective and comprehensive program of earthquake hazard reduction.
6. To review the recommendations of the other advisory groups and draft nizational and policy recommendations for the implementation of the other ups' recommendations.

To obtain the information needed for this report, the group relied on a ety of sources and means, including the following:

1. Reviews of existing governmental organizations and procedures.
2. Interviews with concerned persons and agencies in government.
3. Reviews of selected relevant reports.
4. Interviews with persons knowledgeable in the field of seismic safety and rnmental administration.
5. Reviews of pertinent ordinances and governmental procedures currently ffect.

## SUMMARY OF RECOMMENDATIONS

### Governmental Organization for Seismic Safety

A State seismic safety commission with primary representation from th public, should be established to set goals, develop programs and standard monitor State and local programs, provide information and technical assistanc and order compliance with State standards if, within a specified period of time noncompliance by any State agency or local government is shown.

### Land Use Planning Policies

Land use planning, capital improvement programs, and other land develop ment activities at all levels of government – including environmental contr agencies and governmental construction agencies – should reflect, at the ver least, State seismic safety policies and standards.

### Structural Safety

A program to achieve safety in structures should be instituted, including: (1 formulation and enforcement of engineering standards for new construction based upon both basic and applied seismic safety research; and (2) a two-phas program for the abatement of hazardous buildings.

### Information and Education

The State should develop a multifaceted program of information an education in the field of seismic safety. This program should provide for (1) th education and enlightment of the general public through all appropriate media and (2) the dissemination of pertinent geologic and engineering information t all concerned or interested parties.

### Mutual Aid, Emergency Planning, and Recovery and Reconstruction

1. Mutual aid should be interpreted on a broader basis than presently, and program of financial assistance from State funds should be established.
2. Plans for major emergencies, including an emergency communication plan, should be drafted, adopted, and maintained by every political jurisdiction
3. Recovery and reconstruction programs should be based upon update land use plans that reflect acceptable standards of seismic safety.

### Financing Policies

Financing of seismic safety programs should be achieved by various means t distribute as equitably as possible the costs of such programs among the Federa State, and local governments, and the private sector. Tax reform as related t seismic safety should include such things as (1) a system of incentives an penalties, and (2) the imposition of predetermined, specified, and temporar statewide taxes to restore vital public services after major disasters.

### ıl Aspects of Seismic Safety

Each level of government has the capability of carrying out certain seismic y procedures and controls. These basic legal tools have not been adequately zed. Accordingly, appropriate seismic safety standards should be adopted for and buildings. Procedures are already available for inspection, abatement, demolition of hazardous buildings. These should be given appropriate loyment, using legislative and hearing processes. Moreover, powers should be med and procedures outlined for action in earthquake emergencies. lementation should take place at the appropriate governmental levels.

### ɔptable Earthquake Risk and Priorities for Seismic Safety

As a basis for setting seismic safety standards, the general public, through its esentatives, must begin to determine and articulate acceptable levels of nic risk. Several disparate factors must be considered in order to define such s and serve as a basis for a comprehensive seismic safety program. For this ɔn, the Advisory Group on Governmental Organization and Performance mmends that an overall omnibus bill be submitted to the California slature in 1974.

## GOVERNMENTAL ORGANIZATION FOR SEISMIC SAFETY

### The Basic Role of Government at Each Level

**Federal Government.** Of all the governmental jurisdictions in this countr that at the Federal level is the largest, has traditionally the ultima responsibility for the general welfare of the public, and possesses the greate supply of resources and money. It, therefore, generally plays the primary role seeking to minimize disaster effects and maximize recovery from disaste whether through loans, grants, material resources, insurance, or the large-sc application of manpower and organization.

Federal funding and grant conditions can be a powerful force toward maki State and local governments more able and willing to confront and deal wi seismic safety needs. The Federal Government also has considerable scientif and technical resources for doing research and for monitoring State and loc government performance in the area of seismic safety. It is able to carry on the activities through such agencies as the U.S. Geological Survey, the Natior Oceanic and Atmospheric Administration, the Office of Emergency P paredness, and the Department of Housing and Urban Development, as well through special ad hoc groups such as the Federal Task Force on Earthqua Hazard Reduction.*

**State Government.** The primary responsibility for public health, safety, a welfare lies at the State level. It is therefore the State government which mu make sure that appropriate measures are taken with regard to earthquake haza reduction, disaster prevention, disaster response, and postearthquake recover

**Local Government.** The principal governmental resource at the site of potential disaster is usually that of a local government.† Consequently, loc agencies will of necessity be heavily involved in preventive actions, as well as the immediate on-the-scene response to disaster. This fact, coupled with o strong home-rule tradition, suggests that local government will continue to the primary agent for direct action in resolving seismic problems.

**Regional Agencies.** At a level between that of the State and loc governments, there are logical areas for activities by single and multipurpo regional agencies, including the voluntary councils of governments – such as t Southern California Association of Governments (SCAG) or the Association Bay Area Governments (ABAG) – which should help in achieving the goals seismic safety. Such agencies can, at the least, provide for (1) coordination a interchange of information about seismic safety problems, and (2) regio planning and development programs that give appropriate consideration to maj fault systems, soil conditions, and other earthquake-hazard factors.

* This statement refers principally to regular agencies of the Federal Gover ment as organized on January 1, 1973. Any subsequent reorganizations are n taken into account.

† Local governments are meant to include cities, counties, school districts, a all other public special districts and agencies.

## ooperative Program for Seismic Safety

Because each level of government has an important role in seismic safety, it bvious that a working partnership in this area ought to be established among The State of California should be the prime mover in this partnership to re that seismic safety measures are taken at the appropriate levels and that proper priorities are established.* The proposed program for seismic safety uld include efforts to mobilize governments at all levels, as well as ate-sector institutions, in the pursuit of seismic safety. To this end, ropriate links and working relationships must be established among the eral, State, regional, and local governments. The various elements of the posed program are outlined in the following recommendations:

### 1. Federal Government Responsibilities

In addition to its generally recognized role in connection with hquake disasters, the Federal Government should assume principal respon- ities for at least the following: (a) providing direction, general support, and ds for research;† (b) developing and maintaining effective procedures for the ase of funds for postquake recovery and redevelopment, contingent upon the pliance with appropriate seismic safety standards in the use of such funds; developing and instituting a system of mandatory disaster insurance that uld protect property owners and encourage future building in safe locations according to appropriate seismic safety standards; and (d) developing a em of additional incentives and penalties to help promote seismic safety.

### 2. State Government Responsibilities

To fulfill its responsibilities in the partnership, the State government uld assume at least the following functions with respect to seismic safety: (a) ing specific goals and priorities; (b) devising criteria and minimum standards; developing programs; (d) providing technical assistance; (e) monitoring ormance and reviewing accomplishments; (f) gathering, analyzing, and eminating information; (g) encouraging research; (h) sponsoring earthquake- ty training for local enforcement personnel and other specialists; and (i) sting in the coordination of seismic safety activities among all levels of ernment.

### 3. State Commission on Seismic Safety

A State commission, with principal representation from the general lic, should be established to see that the above State functions are pursued.

* the seismic safety standards of two or more governmental jurisdictions in y area do not conform to each other, the highest seismic safety standard plicable should prevail.

† urther discussion of seismic research needs can be found in U.S. Executive ffice of the President, Office of Science and Technology, *Earthquake Hazard eduction,* Report of the Task Force on Earthquake Hazard Reduction, eptember, 1970, 54 pp.

The commission should consist of nine members, five appointed by t Governor, two by the Senate Rules Committee, and two by the Speaker of t Assembly. Each member's term of office should be four years. The commissi should have a small technical staff, and should establish advisory grou representing appropriate professions, disciplines, and interests. In addition, t commission may require that it be given available information and aid by oth State and local agencies.

The commission should be so organized that it is not primari dependent on any one branch of State government for its ability to investigat disseminate information, and make recommendations. Although the role of t State commission should be primarily advisory and policy making, it should ha the power to order compliance with State standards in the event that any Sta or regional agency or local jurisdiction should fail, within a specified period time, to implement and enforce the seismic safety practices adopted by t commission. The commission should make an annual report on seismic safe progress to the Governor and the State legislature.

### 4. Regional Safety Commissions

Regional seismic safety commissions may be established, as needed, assist the State commission and the local governments. Or, regional seism safety boards or committees may be established within multipurpose region organizations such as the voluntary councils of governments. Such region commissions, boards, or committees should have at least the followi functions: (a) to help review and monitor local performance and progress towa seismic safety goals established by the State commission; (b) to lend technic assistance to local government; and (c) to assist the State commission achieving its objectives.

### 5. Local Government Responsibility

Local governments should have the responsibility and authority to ena and enforce seismic safety measures in such fields as land use planni construction regulation, and disaster response. To the extent that loc governments act, the need for State or regional action in these areas will b reduced.

### 6. Funding

State funds should be provided for the activities of (1) the Sta commission and its staff, and (2) the regional seismic safety commissions, or t seismic safety boards or committees, if established. Appropriate State financi should also be provided to ease the burden on local governments in the compliance with the basic statewide seismic safety standards adopted by t State commission.

### 7. Multipurpose Governmental Organizations

a. *State.* Since seismic safety is closely related to comprehensive lan use planning and environmental quality, the State commission should be s up in such a way as to permit smooth transfer of its powers and functions

an appropriate multifunctional State environmental agency, if and when such an agency is established. Seismic safety should, in that event, receive attention at least equal to any other concern of the environmental agency.

b. *Regional.* If and when multipurpose regional governments are established, seismic safety should be an important element in their programs, plans, and deliberations. Any regional seismic safety commissions that are set up should be organized to permit smooth transfer of their powers and functions to appropriate multipurpose regional governments when the latter come into being.

In the interim, existing voluntary councils of governments, such as the Southern California Association of Governments and the Association of Bay Area Governments, should assist in providing at least (1) coordination and interchange of information about seismic safety problems, and (2) regional planning and development programs that give appropriate consideration to major fault systems, soil conditions, and other earthquake-hazard factors.

## LAND USE PLANNING POLICIES

### The Problem in California

All of California is subject to the effects of earthquakes, consequent attention to seismic safety is required throughout the State. Certain area however, require special consideration due to (1) their proximity to major acti faults; (2) soil conditions likely to produce excessive shaking; and (3) potent for landslides and earth movement, liquefaction, and other such geophysic phenomena.

In these areas, the hazard can be minimized by (1) avoiding intensi development; (2) site planning that recognizes the potential hazards, and locat structures accordingly; and (3) applying special design techniques to earthwor foundations, and building construction.

Land use planning that takes into account seismic safety considerations is essential first step in effectively applying the above hazard-reducing measures.

### Approaches to the Problem

There are two basic types of land use planning situations, each calling for different approach: (1) new development, which should be subjected up-to-date seismic safety planning and design requirements; and (2) existi substandard development which should be subjected to appropriate correcti measures. Federal, State, regional, and local planning activities are involved both. Accordingly, seismic safety should be considered at all of these levels, a the necessary legislation, governmental policies, and administrative actio should be adopted to assure that this is done.

In addition to the traditional planning agencies (e.g., local planni commissions, the State Office of Planning and Research, and so on), there a other governmental agencies – especially those responsible for major capit outlays and building programs – that can exert considerable influence over lar use planning. These include, for example, the State Division of Highways, whic is concerned with freeway location and design, and the State universities, whic select their campus sites and set safety standards for their buildings. Enviro mental control agencies can also have a significant effect on land use plannin and even stronger measures than those currently in effect can be expected fro State and regional environmental commissions such as have been proposed.

In the recommendations below, we outline how government should de with the problem of seismic safety through the various aspects of land u planning.

#### 1. Governmental Mandates

a. Local governments involved in controlling land use or building publ facilities should be required to utilize the expertise in seismic safety availab from qualified geologists and engineers. A local government could do this b employing an appropriate staff, retaining qualified consultants, or securi technical assistance from other governmental units.

b. Charter cities should be subject to the same seismic safety requir ments as general-law cities, but all local jurisdictions should be allowed t

adopt higher seismic-safety standards than those specified by the State.

c. Direct State land-use determinations to achieve seismic safety may be applied where (1) hazard potential, such as the San Andreas fault zone, extends across the boundaries of local or regional jurisdictions, and the safety regulations of adjacent communities are found to be inequitable or inconsistent; (2) local action has been found inadequate; or (3) there is a clear and substantial State interest, as in the case of a complex of State-owned facilities.

### 2. General-Plan Policies

A start in the right direction has been made by the requirement of a nic safety element in the general plans of local governments. But these plans ıld, in addition, be made subject to some higher-level review to determine ı the seismic safety element is adequate, and, more importantly, that all other ıents of a given plan have properly included seismic safety considerations. ı regard to general plans, therefore, the following is recommended:

a. The State Development Plan (required by Government Code Section 65013.2), the State Environmental Goals and Policy Report (required by Government Code Section 65041), and any similar statewide comprehensive plan or policy document which may be required in the future, should (1) include policy statements on seismic safety, (2) identify major active fault zones, and (3) provide for criteria and standards that shall be applied in such zones by all appropriate agencies. The proposed State seismic safety commission should assist the State Office of Planning and Research and the Governor in preparing such seismic safety provisions.

Further, to implement these provisions, the State seismic safety commission – after public hearings – should adopt maps showing seismically hazardous areas that must be considered by local governments and regional agencies in drafting their respective plans.*

b. Regional planning bodies should review and coordinate local governmental plans – including all general plan elements and capital improvement plans – with reference to seismic safety.

c. Regional planning bodies should seek to locate centers of intensive urban growth in places where they do not create pressures for the development of hazardous areas.

d. All planning bodies should – through their open-space plans – recognize the desirability of keeping hazardous areas undeveloped.

### 3. Zoning

Significant geologic hazard zones should be identified by the State, in peration with local authorities where possible. Standards for development

3 520, enacted in the 1972 legislative session, contains parallel provisions quiring maps of hazardous fault zones to be prepared by the State Geologist, d policies and criteria for such zones to be established by the State Mining d Geology Board. It also requires cities and counties to apply these policies d criteria in approving real estate developments. This law does not, however, ply directly to the preparation of local, regional, or statewide general plans.

within such zones should be established subject to public hearings before fi determination.

**4. Subdivision Controls**

a. Local jurisdictions should be given authority to require the subm sion of geologic hazards reports in connection with any subdivision or par map.

b. Local jurisdictions should – through qualified personnel (see above) – perform a geologic review of all subdivision and parcel maps.

c. The public reports on subdivisions issued by the State Real Esta Commissioner should contain statements on geologic conditions. T commissioner should have the authority to deny approval of a public rep if there is reasonable doubt with respect to seismic safety.

**5. Environmental Impact Statements**

It should be required that environmental impact statements inclu considerations of earthquake hazard and seismic safety.

**6. Property Taxes**

a. Since property taxes can influence decisions regarding land use improvements, governments should provide tax incentives for enhanci seismic safety. (See also the discussion under "Financing Policies.") T value of seismic safety improvements should be exempted from the proper tax in some degree.

b. Governments should recognize voluntary or enforced restrictions the intensity of land use – imposed because of geologic hazards – through lower assessed valuation.

c. Governments should provide tax concessions for property damag by earthquakes, or recognized as being made hazardous as the result earthquakes, if its use is consequently restricted.

**7. Redevelopment Policies**

The State Community Redevelopment Law should designate geolog hazards as constituting a blighting condition that may make an area containi such hazards eligible for redevelopment. Federal and State law should provi for a post-disaster redevelopment process that can be instituted quickly followi an earthquake. Present redevelopment procedures are much too slow to useful in a post-disaster situation. Comprehensive community renewal pr gramming should consider the removal or rehabilitation of seismically hazardo buildings.

**8. Critical Structures**

Governments should require special site investigations for the constru tion of all critical facilities, such as nuclear installations, dams, hospita schools, high-rise buildings, and emergency service structures. These inves gations should be subject to review by the appropriate government authoritie

Governments should require a design review by special boards, composed of geologists, soils engineers, structural engineers, and representatives of other appropriate professions, in connection with certain types of development projects, as determined by location, types of construction, and occupancy. Such boards could be provided at the regional level to assist local jurisdictions, as well as to assist State and Federal construction agencies.

**9. Public Facilities**

Site selection, planning, and design of Federal facilities should conform to State and local seismic safety requirements, and should also meet seismic safety requirements adopted for use throughout the Federal Government. In case of conflict, the highest applicable standards should prevail. Plans for the construction of State facilities should conform to the State Development Plan and its policies with respect to seismic safety. The proposed State commission on seismic safety, or its designee, such as the State Building Standards Commission, or the State Office of Planning and Research, should have the authority to review plans of other State agencies for compliance with the seismic safety requirements. The State plan should also comply with any local requirements that exceed State standards.

## STRUCTURAL SAFETY

Achieving the goal of maximum attainable earthquake safety in structure requires a clear determination of who has responsibility for (1) formulatin engineering standards for new construction, (2) enforcing such standards, an (3) reviewing existing structures and repairing or replacing those foun hazardous. To this end, we are making a number of recommendations in each o the above categories as outlined below.

### Engineering Standards for New Construction

1. Since research is essential to the formulation of better and more realisti seismic safety standards, the State should fully support both basic and applie research related to earthquakes and seismic safety. Funds for this purpose shoul be appropriated and allocated directly to universities, to appropriate Stat agencies, and to qualified professional and scientific groups. But the lack o additional research should not be allowed to slow down or stop the utilization o available information that can help improve standards, procedures, and codes.

2. To help supply basic earthquake information for use in research aimed a developing improved structures, State support for seismographic networks an instrumentation should be increased and accelerated. This should includ financial support for the most capable organizations working in this field whether public or private.

3. The State should assist in revising the "Recommended Lateral Forc Requirements" of the Structural Engineers Association of California (SEAOC) in order to incorporate all of the latest research data, and to take into accoun lessons learned from recent earthquakes. The revised recommendations shoul serve as a basis for minimum seismic design requirements for all code agencie within California. The revised code should recognize (a) relevant differences i the performance of various structural materials, (b) the differences of variou foundation materials and types, (c) the effect of different locations within th State, (d) the varying importance of different occupancies and buildin functions, and (e) the importance of the ornamental and non-structural portion of structures. The revised code should then be adopted by each local or Stat agency charged with enforcing building or other pertinent regulations.

In addition to meeting the code requirements for structural design, a critical, unusual, or major buildings should be subjected to special seismologica and geological site investigations. The designs finally approved should be base on dynamic concepts and criteria that may not yet have been incorporated int codes.

4. To help keep building codes up-to-date technically, the State shoul encourage SEAOC, together with other concerned bodies, including universitie and State agencies, to establish specialized working committees for a continuin review of relevant research and new data. These groups should transmit ne findings and recommended code revisions to the State and local governments fo use in seismic safety regulation.

5. State agencies not subject to building codes, such as the Department c Public Works (including the Division of Highways), Department of Wate Resources (including the Division of Safety of Dams), the Department c

lustrial Safety, and the Department of Public Health, should review their ndards relating to site selection, construction requirements, and operations, ad should incorporate the best information on seismic safety into their ndards and regulations. Some form of State interdepartmental advisory board ould monitor such reviews in order to insure the adoption of revised standards ad the effective use thereof.

6. The State, through the universities and community colleges, as well as tough its own agencies, and through professional organizations and seminars, ould foster the professional development of all buildings and structures cialists. The primary aim of such a policy would be to educate and inform se people about current techniques for achieving seismic safety, and about technical bases for the various standards and provisions.

## forcement of Standards

1. The State, through its university, college, and junior college systems, as ll as through its agencies and concerned professional organizations, should ovide schools to train building officials in the requirements of seismic, fire, d general construction safety.

2. Governments should make sure that their building officials have the uisite training and experience to fulfill their duties adequately.

3. In many areas of the State, a specialized competence in seismic safety or sophisticated forms of construction would be underutilized if required of al building officials. In such cases, resource personnel should be available and ovided at cost by the State, the counties, or the larger cities.

4. Building regulations should be enforced locally, but the quality of review d enforcement should be improved, possibly through increased building mit fees. Since building codes must necessarily be limited to relatively simple tements of very complex problems, special seismic review panels should be set in different areas of the State. These panels would review and approve liminary architectural, structural, and engineering plans, participate, as essary, in establishing seismic design loading criteria, and approve the seismic cing systems for critical buildings.

5. State regulations should require that the design professional of record for building review the progress of construction to insure that his design and ns are being properly interpreted and executed. All State agencies should see t their earthquake-resistant-design requirements are met whenever State funds directly or indirectly involved in the construction of their facilities.

6. The State should recommend Federal legislation requiring that all nstruction by Federal agencies comply with local building code provisions for thquake resistance, or with Federal regulations, whichever is higher.

7. A State commission or an interdepartmental State committee should nitor those State agencies whose activities and standards are not governed by ilding codes in order to verify that adequate standards are, in fact, being forced.

## atement of Hazardous Structures: A Two-Phase Program

Older structures in this State constitute one of the major hazards to life and

property because, for the most part, they were not designed to be earthquake resistant. The existing huge inventory of such buildings means that the abatement problem is complicated and its solution costly. Hazard-abatement policies will have to be worked out carefully, with full consideration of their social and economic impact, and other possible consequences. Programs of hazard reduction will have to be scheduled according to a realistic timetable employing priority systems based on expert evaluation of hazard levels.

Accordingly, the problem can conveniently be broken down into at least two phases. The first phase could consist of a methodical program of hazard reduction, concentrating primarily on older buildings presumed to represent the greatest danger. The second phase could consist of an inventory and study program, undertaken to assess and evaluate the nature and magnitude of the danger posed by the less hazardous buildings not covered in the first phase.

Such a two-phase program would make it possible to start immediately toward eliminating the worst structural hazards, while also developing realistic information on the magnitude of the larger task of reducing the remaining ones.

**1. First Phase: Eliminating the Most Hazardous Buildings**

a. Government should require that every building meeting all of the following criteria be inspected, and that after review and analysis, any such building found deficient* should be reinforced or demolished no later than six months after the deficiency finding is final:

(1) The building was constructed before 1933, or a later designated date. Later dates may be established for specific local jurisdictions, based on an evaluation of each jurisdiction's history with respect to design standards and effectiveness of enforcement. This should probably be done by the proposed State commission on seismic safety.

(2) The building lies within a zone designated as probably subject to substantial earthquake shaking. To facilitate administering the hazard reduction program, the zone areas should conform to existing governmental boundaries, and avoid bisecting individual local jurisdictions.

(3) The building is of "Type III" construction with load-bearing unreinforced masonry walls using lime mortar, and wood floors and roof.

b. Priorities of building inspection and reviews should be assigned on a block-by-block basis, with buildings of greatest occupancy density receiving highest priority, other factors being equal.

c. A hearing process should be established to facilitate expeditious hazard-abatement proceedings, as well as to guarantee fairness and due process.

d. Building occupancy levels should be considered in making decisions on the priority of abatement. Thus certain high-hazard buildings might be allowed to remain, if only low occupancy levels were involved. Dangerous buildings permitted to remain should be posted with signs clearly stating the degrees of hazard.

* A building would be considered deficient if it failed to meet the requirements of the *Uniform Code of Repair, Vacation, or Demolition of Dangerous Buildings* (Vol. IV of the *Uniform Building Code,* latest edition.)

e. Special precautions should be taken to insure that occupancy levels in hazardous buildings are not increased.

f. Buildings of historical significance – and that have low occupancy levels – as determined by the appropriate local jurisdiction may also be exempted from hazard abatement procedures.

**2. Second Phase: Taking Stock of Less Hazardous Buildings**

In the second phase of the program, less hazardous buildings should be identified, or estimates made of their prevalence, location, and degree of hazard posed. This could be done on the basis of existing data, or on the basis of field sampling by competent engineers. The information thus obtained should, in turn, make it possible to estimate the magnitude and cost of the task of hazard reduction, including the number and kinds of personnel needed to carry it out. These estimates would make it possible to carry out the program in realistic stages over a period of many years. The program should also include specific recommendations for financing all of the work that will have to be done.

**3. Implementing the Program**

a. An existing State agency or a new State seismic safety commission, as previously proposed, should be given overall responsibility for the first phase of the program. The designated agency should set the specific program goals, devise necessary criteria, get the program under way, and monitor its progress. The agency should also make periodic progress reports to the Governor and the State legislature, including recommendations for additional legislation and/or financing, as necessary.

b. Existing local jurisdictions should have primary responsibility for implementing and carrying out the hazard-abatement program, under the general State-set criteria.

c. The State should enact legislation (1) expressing legislative intent that the program be undertaken, (2) making the State and local functional assignments outlined above, (3) providing for funding, and (4) perhaps also providing for a system of incentive payments – to both individuals and communities – for extraordinarily good performance, and penalties for failure to meet State criteria.

d. To the greatest extent possible, programs or urban redevelopment should be coordinated with, and employed to help implement, the program of hazardous building abatement.

e. The second phase of the program – a sampling of inventory of other building hazards not covered by the first phase – should be undertaken under the auspices of one or more suitable agencies, such as the Department of Housing and Urban Development, an institution of higher education, the State Office of Architecture and Construction, the State Office of Emergency Services, the Governor's Earthquake Council, or the proposed State commission on seismic safety.

**4. Additional Measures**

The State should also evaluate other existing structural entities, such as dams, bridges, highways, towers, and airports, and take whatever corrective action may be indicated to achieve adequate levels of seismic safety.

## INFORMATION AND EDUCATION

To do a proper job of promoting seismic safety, at least four kinds o information and education programs are needed. Each involves a somewha different approach, is directed to a different type of audience, and is meant t serve a different purpose. The proposed State commission on seismic safet should take the responsibility for developing and implementing the fou programs, which are outlined below.

### Promoting Public Support for Seismic Safety

Generally speaking, seismic safety programs seem to lack public support probably because major earthquakes occur too infrequently. Yet, there is grea potential for catastrophic loss when such earthquakes do occur. Accordingly, w recommend the following:

1. Pamphlets, films, newsletters, flyers, and the like, should be produce and widely distributed, emphasizing that preventive seismic safety measures such as land use controls and design techniques can be effective, and at relatively lo cost.
2. Public school curricula should include material explaining the nature o earthquakes, and also emphasizing that it is possible to avoid substantial damage.
3. A periodic status report prepared by the proposed State commission or seismic safety should indicate the current overall level of seismic safety in the State and the degree of progress, or lack of it, in comparison with previous reports.
4. A public information office should be set up to assist the news media in disseminating newsworthy seismic safety information, and to carry on othe suitable promotional efforts such as an annual Earthquake Preparedness Day.

### Information to Guide Individual Behavior

1. Information should be published and distributed telling the individual where he can find help in evaluating the safety of his home or other property, and suggesting how he can obtain assistance toward improving the safety of such property.
2. Efforts to disseminate information telling the individual what to do in an emergency should be expanded by such means as earthquake drills at schools and offices, films, and emergency instructions printed in the telephone book.
3. Information on sources of aid for recovery should be ready for distribution immediately following an earthquake.

### Information for People with Special Functions

Certain members of the public have — by virtue of position or interest — a special role in seismic safety. These people include civic leaders; public officials; building inspectors and plan checkers; engineers, architects, and planners; people in real estate — lenders, developers, brokers, salesmen; and educators. The program directed towards such individuals should include suitable courses, seminars, workshops, conferences, and mock exercises.

**formation About Seismic Hazards**

1. A statewide clearinghouse for geologic surveys, reports, and other relevant blications should be established.

2. The State and Federal governments should undertake geologic mapping ograms in cooperation with local jurisdictions where possible. Maps showing nes of possible geologic hazards should be made readily available to all erested parties, and especially to the real estate industry.

3. The State should provide all other pertinent geologic information to local isdictions, and require that such information be made available to the public.

4. Environmental impact statements that include seismic safety consid- ations should be used as a public information tool.

5. The State Real Estate Commissioner's public reports on subdivisions ould include comments of a geologic nature in all cases, thus providing vital formation to potential property buyers.

6. Hazardous buildings should be posted as such to warn the public of the nger.

7. Building departments should be prepared to provide information on the ismic safety of buildings which they have inspected, and to make inspections a reasonable fee for the information of prospective buyers, tenants, and other terested parties.

8. Official reports concerning hazardous lands or property improvements ould be recorded so that the information will appear in property title reports.

## MUTUAL AID, EMERGENCY PLANNING, AND RECOVERY AND RECONSTRUCTION

### Mutual Aid

In California, 392 cities, 58 counties, and the State have signed the California Disaster and Civil Defense Master Mutual Aid Agreement. Thus far various fire and police forces throughout the State have utilized mutual aid, but there has been little application of this device to other forms of public service. Futhermore, the cost for mutual aid has fallen very unevenly among the political jurisdictions and tax collecting entities involved. Consequently, in the field of mutual aid, we make the following recommendations:

1. Mutual aid should be interpreted broadly. Moreover, public officials must understand that the above agreement also includes State agencies with concern in such areas as sanitation, water, and manpower supply.

2. Mutual aid activities should be financially assisted by the State and possibly through an insurance program as well.

3. Specific mutual aid plans should be systematically developed and exercised among appropriate political jurisdictions, and together with all nongovernmental elements involved.

4. The possible exposure of an assisting mutual aid agency to legal liability for personal injury or property damage sustained by a third party, due to the negligence of the officers, agents, or employers of the assisting agency, creates another problem. Since penalties can be imposed against "Good Samaritans," anyone who is under no obligation to perform an act of assistance, but who elects to do so, may then be under an obligation not to do it negligently.

It is also suggested, that the public agency extending aid protect itself by appropriate "hold harmless" clauses, supported by appropriate insurance coverage. Reciprocal "hold harmless" clauses, containing appropriate language dealing with both the aiding and the aided agency, may be one solution. Review of the provisions with the public agency's insurance carrier would probably be sufficient to obtain necessary insurance coverage.

### Emergency Plans and Operations

Government at all levels should develop plans for major emergencies – with emphasis on earthquakes – to deal with all types of disasters. The following recommendations are intended as a basis for effective emergency programs.

1. Every political jurisdiction must be required to draft, adopt, and maintain plans for major emergencies, both natural and man-made. This requirement must include special districts and public utilities that provide essential services such as water, sewer, and gas and electric, as well as counties, cities, and the State.

2. Scheduled and surprise exercises of official emergency plans must be made a general requirement.

3. Emergency communications must be maintained on the State, regional, and local level, with an effective tie-in to the public information media. Every organization with a public-service function should be required to plan for the effective emergency use of the communications facilities available to it.

4. Emergency plans should specify in detail the task assignments for departments and agencies having an emergency-response function, and designate the persons in charge by job title.

5. All forms, resolutions, proclamations, and announcements needed to implement major emergency plans should be prepared in advance, for use during an emergency.

6. Local governments must be prepared to help the State and Federal governments set up disaster assistance centers as one-stop service facilities for the emergency needs of victims, and to provide public information in connection with the emergency on a local basis.

## Recovery and Reconstruction

After a major disaster, a great effort is generally made to bring the community back to normal. This *can* mean reconstructing a community just as it was before disaster, and thus perpetuating old problems, hazards, and mistakes. The post-disaster period should be utilized carefully to enhance the future safety of the community even while recovery measures are being taken. To this end, we make the following recommendations:

1. One-stop disaster assistance service centers should be set up, as previously mentioned, to supply disaster victims with all forms of information and guidance concerning the availability of disaster relief.

2. Updated land use plans, with recommendations for improvements in such things as street widths, location of facilities, and zoning should be developed to guide the reconstruction of the community along proper lines.

3. To facilitate recovery operations, records should be kept and agreements made relating to alternative sources of water, power, and other necessary services from surrounding communities and agencies.

4. Incentives should be set up to encourage the complete removal, rather than merely the repair, of badly damaged buildings whenever this is made desirable by new land use plans and the goal of providing better and safer facilities.

5. There should be an officially designated body at the local level with the expertise necessary to allocate resources, including manpower, to accomplish all recovery goals previously agreed upon.

## FINANCING POLICIES

Public funds seem always in short supply and must be allocated among th State's many competing demands. Under these conditions, seismic safety shoul be recognized as one of the State's priority needs, so that sufficient funds can b allocated to it, and stand-by devices employed to help raise additional money a needed.

There is always the basic question of who should foot the bill. Should it b the public in general, the owner of the endangered property, or the user of th property or facility? One possible answer is that costs should generally be prorated among those who benefit from the expenditure. This means tha sometimes the public as a whole pays the bill, that sometimes the user or owne of the property pays the bill, and that sometimes the costs, and benefits, ar shared. In an effort to resolve the dilemma, we offer a number of recommenda tions and suggestions in the area of financing seismic safety, as outlined below

### Recommendations

1. The costs of projects benefitting the general public should be paid out o the State's general funds. This would include expenditures for research anc seismic safety education of the public. In this age of great mobility, there is a scarcely a California citizen who does not at some time travel to earthquake prone territory, or whose economic well-being does not to some extent depend on the survival and normal functioning of communities located in earthquake areas, or who is not in some way affected by the transportation, power, and water systems that straddle the State's earthquake fault zones.

2. The cost of seismic safety inspection and the training of inspectors should be borne primarily by the property owners involved, but should be partially subsidized by local tax funds. Because the public does benefit by the inspection of places of public assembly or other public use, some portion of the costs for these inspections should be defrayed from the general tax funds.

Money spent for checking construction plans and carrying out inspections in connection with seismic safety should be included as part of the construction costs. Charges for the training of inspectors in this connection should be set on a sliding scale, so that projects presenting a greater seismic safety risk, or entailing greater inspection and plan-checking costs, will contribute accordingly.

Total city and county revenues for building inspections in California in 1970-71 were $36,882,664, which probably represents something less than one percent of the total cost of construction. More careful study will be required to determine how much additional money will be needed for effective seismic safety inspection and enforcement.

Since the cities and counties should be encouraged to establish model inspection programs, a part of the costs of inspection and training could be defrayed by the State, as an incentive to local action.

3. A property-tax penalty or surcharge of X percent could be levied on all properties deemed unsafe after inspection, and, as an incentive, a property-tax credit of Y percent could be given property owners who can demonstrate improvement of the property above minimum earthquake standards, up to Z percent of its assessed valuation. Any penalty money received should be used to

mburse local government for revenue lost through the granting of tax credits.

4. Special charges should be levied on all subdivisions or buildings planned r property within designated earthquake-hazard zones. This money should go the local governments and should be used for training inspectors and other rsonnel involved in checking plans for earthquake safety requirements, as well for other seismic safety purposes.

5. The cities, the counties, and the State should contribute X percent per ar – based on the assessed valuation of property improvements (excluding blic utilities) – for mutual aid insurance and to reimburse local entities whose tual aid costs exceed Y percent of their revenues from property taxes.

6. An amusement/occupancy tax could be charged on admission prices to aces of public assembly, to be used for the study, inspection, research, and provement of places of public assembly with a high potential for deaths or juries in a disaster.

7. Seismic safety improvements could be authorized through the various ate Assessment Acts and could be partially financed from Federal, State, or cal contributions.

8. Property owners should be encouraged to keep hazardous property in a n-use or limited-use status. This could be done through provisions – like those the Williamson Act* – which would reduce assessments on properties clared as constituting seismic safety hazards.

9. In the case of an earthquake disaster, the Governor should be authorized proclaim a state of disaster and to impose previously specified temporary atewide increases in taxes, to be used by the State and local governments to fray the costs of restoring public services. This could include roads, power and ater facilities, and essential public buildings such as hospitals, communications nters, schools, and so on.

Land Conservation Act of 1965, Section 51200 and following of the Government Code.

# LEGAL ASPECTS OF SEISMIC SAFETY

In this chapter, the problems of dealing with seismic safety on the local leve are divided into three broad categories and discussed in the following order: (1 legislative measures; (2) administrative procedures; and (3) emergency powers including mutual aid agreements.

Logically, a community wishing to address the problems of seismic safety should consider taking legislative steps first. There are good reasons for this: Owners of improved real property would have a weaker argument in saying tha the community is discriminating against them or their property if legislative action has been taken to forestall the future problems. Conversely, the community can point to the fact that it has acted to prevent future seismic problems as it begins to address existing seismic problems.

Moreover, it is desirable to be able to respond to critics of any program by demonstrating that the action taken is part of a comprehensive master plan, and that any special group or property owner is only one small but necessarily affected portion of the overall program.

## Legislative Measures

**Zoning and Land Use Ordinances.** The law presently requires the inclusion of a seismic element within a local agency's general plan (Government Code Section 65302 and 65302.2), and zoning is required to conform (Government Code Section 65860). Consequently, with respect to action to lessen seismic risks, zoning and land use controls should be among the initial considerations. Zoning, subdivision, and land use ordinances can be utilized as reasonable controls and limitations on land use, density, lot or parcel size, and density or level of occupancy. In addition, such measures can also provide some degree of control over the size of structures, and the quality and quantity of improvements on real property, especially with respect to roadways, sewer lines, water lines, and other utility services. The local public body can initiate such controls through the legislative process. The necessary ordinances should be supported by detailed findings of fact, developed in part through a public hearing process prior to adoption of the legislation. For example, if it is desired to reduce population densities within a certain area of a fault zone, the public agency should encourage experts to appear. Geologists, engineers, and seismologists (if available, and if justified by the magnitude of the zoning action in the area, the property value, or the potential hazard to property), qualified building officials or other qualified and experienced builders might testify in support of the proposed legislative action, and could present useful evidence, findings, and expert opinions.

Housing and land use controls have been established as a legitimate use of the police power. The courts have held that a public agency may legally exercise its inherent police power if necessary to protect the public health, the public safety, or the general welfare. Most decisions, especially those of recent origin, have construed the general-welfare portion of the police power broadly. In addition, courts have held that the police power, and especially the general welfare portion thereof, is an elastic and dynamic concept that changes with the times.*

* *Miller vs. Board of Public Works* (1924) 195 Cal. 477 at p. 485.

A public agency might also consider down-zoning property shown to be l ated in a seismically questionable area. Zoning proceedings could be initiated b a relevant occurrence, such as the receipt of new evidence that an area is usafe or improperly zoned, in view of the seismic hazards involved. An dinance could provide that, upon the receipt of additional information (for ample, evidence resulting from the occurrence of an earthquake) certain perties located within the quake area would be subjected to a public hearing t determine whether the existing zoning should remain. In these situations, the rionale would be that in the interest of the public safety, property zoned for i ense use would be considered for zoning to a less intense use. This process ght be sufficient for open-space or non-developed land. In the case of perty that is already improved, down-zoning could stop or reduce further i ense development. In the extreme case, rezoning an improved property to a s intense zone would place the property in a nonconforming status.

Under the typical zoning ordinance, nonconforming structures not used for a ecified period of time are subject to removal to conform to the zoning quirements. This type of proceeding has been utilized in eliminating outdoor vertising from certain areas or zones. The courts have supported this cedure in actions to abate signs, provided the action was reasonable and did t result in the condemnation of property or property rights without the portunity to recover the cost of the property or improvements being taken.*

**Moratoriums.** Finally, moratoriums on the issuance of permits and zoning n be utilized. Such tactics have been supported by the courts.† However, they uld not be lightly enacted; they should not extend for long periods of time so to deny property owners the use of their property for unreasonable periods; d they should be used only in grave situations pending an immediate study d recommendations by the proper official as to what should be done with the a subject to the moratorium.

With regard to standard-setting, the local community could consider endments to its building codes to establish higher building standards for smic safety. Assembly Bill 2300 (1970) now codified in Health and Safety de Section 17922, 19751, 17958, 19758.5, and 17958.7 allows a local public ency to enact special building code provisions different from the Uniform ilding Code, provided the agency can justify such legislation as "being asonably necessary because of local conditions."‡

**Amortization Ordinances and Down-Zoning.** Some cities have enacted dinances amortizing designated old buildings, or limiting the right of owners to prove them. Ordinances placing old buildings under an amortization schedule d subjecting them to ultimate demolition should be considered and enacted by cal agencies, if necessary, in connection with their hazard abatement programs. dequate consideration should be given to the procedures for classifying the

See the California Continuing Education of the Bar, volume titled *California Zoning Practice,* page 351, Sec. 8.53, 8.54

*Miller vs. Board of Public Works,* op. cit.; *Hunter vs. Adams* 180 C.A. 2nd 511.

Health and Safety Code Sec. 17985.5

structures, and giving notice to all parties with special legal interest in th property, since these ordinances have not been subjected to as much judicia testing as have the sign ordinances.

The reason down-zoning and other use-limiting powers should be handle with restraint is that they otherwise may impair the integrity of the local zonin process, and subject local public agencies to litigation claiming the impropel taking or abuse of property rights. The field of inverse condemnation is nov receiving closer scrutiny by the members of the bar representing propert owners. Any action taken should be supported by factual documentation preferably developed at a public hearing.

The down-zoning of property, amortization of property, and other sever limitations on property use, should be employed sparingly and judiciously. Whil the placing of outdoor advertising signs in a nonconforming status, subject t eventual abatement, has been approved in some cases, as stated above, to th knowledge of the group, this has not yet been done with buildings. However, i would appear to be a valid legal principle for application in extreme cases.

## Administrative Procedures

Most serious seismic hazards exist in the form of older buildings (although al hazardous buildings are not necessarily old) in urban areas. Often these building are generating a high rate of return, considering their age and condition. In th interest of fair and equitable treatment, it is desirable to be able to tell th owner that standards have been established for future building, and that existin hazards must now be taken care of.

The Uniform Building Code, Volumes I and IV, establishes some standard for the evaluation of older buildings. The local public agency should establisl criteria under which it will consider and review old buildings or those it ha reason to believe are hazardous. These criteria could be adopted by the locality' chief building official as part of the rules and regulations of his office or coul be adopted by the local public agency in resolution or ordinance form.

The Uniform Building Code vests broad and rather arbitrary powers in th chief building official, authorizing him to evaluate and abate by demolition, i necessary, extra-hazardous structures, with little or no notice and without hearing. In view of the availability of inverse condemnation challenges, in th case of property owners who believe their property has been illegally damaged o taken, the local public agency should enact its own procedural ordinance fo hazard abatement hearings. The ordinance should provide for notice to be give to the property owner by the local public agency of its initial findings an tentative decision, together with notice of a hearing relative to the allegations At such a hearing, property owners should also be allowed to present evidence i rebuttal. In addition, the local public agency should also notify other partie who have a long-term interest in the property, such as lessees, mortgagees holders of mechanics' and other liens, joint owners (spouses), and others wh have substantial legal or financial interests.

Whenever possible, initial hearings should be conducted at a level below tha of the local legislative body, for example, by a board of appeals. This will reduc the local legislative workload by removing the local legislature from the initia

hrings and allowing it to act as a review and appeal body. This facilitates stling matters without resorting to court action, except as a last measure.

What should be done in a legitimate emergency wherein a building is an imediate hazard and should be closed and demolished forthwith? In such a siation, the chief building official should post the building and require the geral public to stay out, pending a hearing on the matter. If the aggrieved pty loses at all levels of the hearing process, he can still sue in the courts. Hwever, the scope of review of the appeal is limited to a review of the record of te proceedings by the local public body, and the local attorney is, therefore, in a ood position to develop a record favorable to the local public agency.

## hergency Powers

Only a little need be said here about emergency powers and mutual aid, as ty are discussed more fully elsewhere. It should be pointed out, however, that te law does grant public bodies general and broad emergency powers, and the ponsible public counselor should check the local charter and its ordinances, as ll as the general law.

Suffice it to say that the authority for the use of emergency power is implied i the police power. If only limited local law can be found, it is recommended at counsel for the local public agency prepare a relatively simple ordinance tlining procedures for use during periods of extreme emergency. Such items as ain of command, responsibilities of individual officials, official duty stations, d general procedures during emergencies should be considered.

Agreements with regard to mutual aid should be periodically reviewed and dated. The local public agency should be fully aware of its responsibilities and hts under such agreements.

## BASIC CONCEPTS: ACCEPTABLE RISK AND PRIORITIES FOR SEISMIC SAFETY

There is no condition of absolute safety: every facet of life has som element of risk. Accordingly, it is essential to develop ways of deciding ho much earthquake risk is acceptable, in order to guide appropriate public agencie in bringing hazards down to those levels. Most risk reduction efforts will enta both fiscal and social costs. Consequently, several factors must be considered i defining acceptable risks in relation to the outlays involved.

### Defining Acceptable Risks

The first factor to consider is that *there is no uniform level of risk acceptable to the public.* While maximum safety is desired, the demand must be related t costs, and varies with time, place, occupation, culture, and other factor: Subjective feelings, emotional reactions, and even irrational considerations als help determine the hazard levels that various publics will accept. Demands fo increased safety always follow a disaster – demands for seismic safety after great earthquake, for storm protection after a hurricane, for transportatio safety after a train accident, and for better fire protection following a large fir After a time, however, the public tends to forget the disaster, and the require level of safety is often lowered.

A second consideration is determining acceptable risk concerns its relation ship to other natural hazards. Historically, overall earthquake losses in Californi have been quite minor, as compared to other natural disasters, both in Californi and elsewhere. The San Fernando Earthquake of February 9, 1971, for example is reported to have cost 58 lives and $500 million dollars, and it received muc publicity. The following year, Hurricane Agnes cost 237 lives, and two week later the Pennsylvania floods killed 118. Both events received less publicity tha San Fernando.

But past history may be misleading, as California has had no grea earthquake since 1906. Most of the State's urban development and populatio growth has occurred since that date. Thus, the earthquake menace is stil formidable, although the cumulative total of past earthquake losses is out weighed by those caused by other natural disasters.

In fact, the potential for earthquake disaster has increased vastly in th intervening years since 1906. For example, it has been estimated that a majo earthquake in the San Francisco Bay Area could cause 10,000 deaths, and resul in several billions of dollars of damage. While similar studies have not as yet beer completed for Southern California, it is probable that a major earthquake there could cause a comparable or even greater disaster. Moreover, secondary losse and social effects would be substantial.

All goals of society have values that must be weighed against the costs o achieving the objectives. Thus, increased earthquake safety – or reduced risk – can be attained with today's technology, but only at a cost. Accordingly cost-benefit ratios must be assumed in order to guide choices among goals. Bu the data required to establish these costs and benefits often are not available. Moreover, the costs and benefits often can only be stated in nonquantifiable terms, or when measurable, are rarely expressed in compatible units that permi

comparisons between goals. Consequently, the evaluation of the cost-benefit ratio, and the definition of an acceptable risk, must be based on informed human judgement, considering all of the above factors in their relation to the other needs of society.

In the absence of either readily quantifiable information or of compatible risk measurements, we instead express risk levels *in terms of what should be achieved, and also employ cost to indicate a limiting upper level of effort that society probably can afford.* Obviously, present technology may not as yet be able to deliver the full degree of assurance that we would prefer. Nevertheless, this risk-evaluation concept can help guide what we do with technology.

## Risk Levels That Should Not Be Exceeded

Considering all of the relevant factors, our judgement would indicate that the following risk levels should not be exceeded. That is, risk levels above those indicated should be considered unacceptable.

1. The highest level of safety attainable with present technology is required in the nuclear field. In effect, the criterion is: safety at any cost. The public has demanded this extremely high level of safety—or low level of risk—to the point where advanced theories and design concepts are sometimes employed, even though there may be little or no foundation in experience or hard evidence to demonstrate conclusively the necessity for many of the stringent requirements. In terms of earthquake safety, it is probable that large dams should also be included in this category, as well as such facilities as electric power inter-tie systems and plants manufacturing explosives.

2. The second category of structures are those whose use is needed after a disaster, and/or those whose failure would be only slightly less disastrous than failure of a nuclear facility or large dam. They should also embody a high level of safety, although less than in the previous category. The principal safety goal should be structures and facilities that will continue to function after experiencing an earthquake disaster. Examples would be smaller dams, important utility centers, hospitals, fire, police, and emergency communication facilities, and critical transportation elements such as bridges and overpasses. These should be designed and built as safely as modern technology permits. An extra project cost of 5-25 percent to provide that level of safety would not be excessive. In some cases, where present technology cannot assure maximum attainable safety, redundance may be necessary. The above statements are not intended to urge theoretical and advanced design techniques comparable in cost-benefit ratios to those used for atomic energy installations, or the other extremes of high safety requirements associated with nuclear devices.

3. In a third category are other structures that – for emotional reasons, occasional high occupancy, need for use after a disaster, etc. – should have as little risk of collapse as is economically possible, and also should protect the occupants from serious hazard to the highest degree possible. Under these criteria, such structures could be damaged to a point where their functions were impaired, but their continued functioning – under difficulties – would still be possible. Some injury would possibly occur from falling articles, etc., but loss of life would be rare. Facilities in this risk category would include schools,

churches, theaters, large hotels, other places normally attracting large concen trations of people, civic buildings such as fire stations, secondary utility structures, extremely large commercial structures, most roads, alternate o noncritical bridges and overpasses, most utilities, etc. The degree of safety required in this class of structures would be attainable by a 5-15 percent increase in construction cost.

4. The vast majority of structures consist of commercial and industria buildings, small hotels and apartment buildings, and single-family residences, fo which an "ordinary" degree of risk should be acceptable. The criteria envisioned by the Structural Engineers Association of California provide the best definition of the "ordinary" level of acceptable risk. These criteria require that building should be able to:

a. Resist minor earthquakes without damage;
b. Resist moderate earthquakes without structural damage, but with some nonstructural damage;
c. Resist major earthquakes, of the intensity or severity of the strongest experienced in California, without collapse, but with some structural as well as nonstructural damage.

In most structures, it is expected that structural damage, even in a major earthquake, could be limited to repairable damage.

Even with the above goal, the level of technology at present is such tha some major failures will occur in a large earthquake. In most cases, the added construction costs for this degree of safety would only be 1 to 2 percent. I many cases, the cost would be less. Single-family residences could comply for a fraction of a percent of construction costs. In some instances, however, added costs might run between 2 and 10 percent.

5. A very large number of existing buildings cannot possibly provide th degree of safety envisioned in any of the above classes. These buildings should b retired as soon as society can afford it. This has been discussed earlier.

The concept of risk in human affairs is always complicated, usuall controversial, and frequently imponderable. Nevertheless, studies of seismi safety have clearly identified several levels or orders of magnitude in earthquak hazard.

Such simplified rankings of risk may be translated directly into basi priorities guiding the employment of resources and regulations in the interest o seismic safety. Success or failure in implementing these priorities will depen largely on how well government is organized to deal with earthquake hazard, an on how well it performs in the process.

## CONCLUSION

The Advisory Group on Governmental Organization and Performance has focused primary attention on public policy and performance with respect to seismic safety. This primary concern has necessarily included such matters as governmental organization, land use policies, structural safety, disaster recovery and mutual aid, public information and education, finance, legal considerations and concepts of acceptable risk.

From its studies, the advisory group concludes that an overriding need exists for a statewide comprehensive approach to the seismic safety problem in California. Accordingly, we are persuaded that an omnibus bill on seismic safety would (1) facilitate legislative consideration of and action on the many interrelated aspects of seismic safety policy; (2) require appropriate review of all relevant codes in drafting seismic safety legislation; (3) help focus legislative and public attention on the urgency of a comprehensive approach to earthquake hazard reduction; (4) serve as a central point of policy reference and include all aspects of the basic legislative package*; and (5) help ensure comprehensive, systematic, and thorough treatment of California's seismic safety needs.

Accordingly, it is appropriate for the report on Governmental Organization and Performance to conclude by recommending that the several components of the basic legislative package be included in one seismic safety measure to be introduced as the California Seismic Safety Act of 1974.

*See Part One

# MEETING THE EARTHQUAKE CHALLENGE

---

## Part Three: Supplementary Information

# APPENDIX A: HISTORY OF OFFICIAL STATE GOVERNMENT INVOLVEMENT IN EARTHQUAKE SAFETY

What has been done to reduce earthquake risks in California? The San Fernando earthquake of February 1971, unlike so many previous California earthquakes, continues to receive great attention from all levels of government, from the universities, and from the private sector, more than two years after the event. It may have provided the impetus for efforts which will lead to a truly significant improvement in seismic safety for the citizens of this State.

Outlined below is a chronology of the salient events involving the State government in the area of seismic safety.

## Chronology

### 1872

Perhaps the first official evidence of concern by the State about earthquakes was the reprinting in full in the eighth annual report of the State Mineralogist (now State Geologist) in 1888 of J. D. Whitney's two papers on the Owens Valley earthquake of 1872. These were originally published in the *Overland Monthly* of September and October 1872. It is interesting to note that the earthquake of 1872 was felt in Sacramento and that the new capitol building (built in 1868) was damaged when an iron supporting column broke.

### 1906

The first major step in State participation in earthquake investigation was taken by Governor George C. Pardee when, three days after the great San Francisco earthquake of April 18, 1906, he appointed the State Earthquake Investigation Commission. The commission was chaired by Professor A. C. Lawson, renowned University of California geologist, and manned by other experts of the time, including J. C. Branner of Stanford's Geology Department, G. K. Gilbert of the U.S. Geological Survey, H. F. Reid, professor of geology at Johns Hopkins, and several noted astronomers. Following the earthquake, the Carnegie Institution of Washington published the monumental *Report of the State Earthquake Investigation Commission* in two volumes and atlas* which contains one of the greatest accounts of an earthquake ever published.

### 1933

Nineteen thirty-three was another year of disaster, with California's third most costly earthquake occurring in the Long Beach area on March 10. Disastrous structural failure of dozens of school buildings prompted the State Legislature to quickly pass the Field Act†. Among many other things, this act requires the State Office of Architecture and Construction to set up rules and regulations concerning earthquake safety in the design and construction of school buildings. These regulations are now included in Title 21 and Title 24 of the California Administrative Code. The law is not retroactive, however, so that

*Reprinted in 1969 and available from the Carnegie Institution, Washington, D.C., for $12.50.

†See Appendix B, for detailed description of the Field Act.

school buildings in the State are now unofficially categorized as either *approv* or *unapproved.* The act has, nonetheless, been highly successful in reduci damage in subsequent earthquakes and other disasters. (The problem of t continued use of the older, unapproved school buildings is being attacked by t Garrison Act requiring that unsafe school buildings be brought up to mode earthquake-resistance standards by June 30, 1975, or their use discontinued.)

## 1940

The first test of the Field Act's effectiveness was provided in 1940 with th El Centro earthquake. Essentially no damage was sustained by post-Field-Ac schools.

## 1952

July 21, 1952, is a noteworthy date in California earthquake history. Th major, magnitude 7.7, Arvin-Tehachapi earthquake caused the loss of 14 liv and $60,000,000 in property damage, at the same time that it confirmed th successful application of the Field Act toward maintaining damage to scho buildings at a low level. State Division of Mines Bulletin 171, titled *Earthquak in Kern County During 1952,* firmly established earthquake investigation an publication as a proper activity of the division and launched the State on a accelerating program of earthquake investigation and publication.

## 1957

After the San Francisco earthquake of March 1957, the division published i Special Report 57, which reviewed the geologic situation and added informatio on the San Andreas fault and the 1957 earthquake.

## 1964

The great Alaskan earthquake of March 1964, reviewed in the field b representatives of the State, served as the impetus for two conferences sponsore by the Resources Agency, of which the division is a part. The conference repor were: *Earthquake and Geologic Hazards Conference of 1964,* and the *Geolog Hazards Conference of 1965.*

## 1969

In response to an increasing interest in earthquakes, Senate Concurren Resolution 128—relating to a Joint Committee on Seismic Safety—was file with the Secretary of State on August 25, 1969. The Joint Committee o Seismic Safety thus set up consists of four members of the senate plus fou members of the assembly. The committee is advised by five advisory group each made up of 14 or 15 authorities in the field. The resolution states that th Joint Committee "shall file a final report with the Legislature not later tha June 30, 1974."

The first report of the committee (California Legislature, 1970) summarize the work of the advisory groups to June 30, 1970, including information o organization, a program plan, a summary history of surface faulting an

derate-to-great earthquakes, a list of objectives and work schedules, and a nario-like description of effects that may be expected in earthquakes.

The Joint Committee held two hearings during 1970 and the information ned, together with the extensive background material developed by the isory groups, enabled the legislators on the Joint Committee and other mbers of the legislature to propose a series of bills related to earthquake ety.

The San Fernando earthquake of February 9, 1971, greatly stimulated erest and action concerning earthquakes and their effects in California. On ril 27, 1971, enabling legislation (Joint Rules Committee Resolution 7) was sed asking the Chairman of the Joint Committee on Seismic Safety to oint a "special three-man subcommittee to conduct an in-depth investigation, l report on its findings relevant to events prior to, during, and after the Los geles earthquake of February 9, 1971." Complete, in-depth studies by the sultants to the subcommittee were published in July 1972 in the following thquake subject areas: structural engineering, geological and seismological ons, dams and soils, city lifelines, land-use planning, disaster preparedness, l government organization and performance.*

The Joint Committee has continued to promote seismic safety by various ans, including public information activities, public hearings, investigations of t disasters and current standards, the introduction of legislation and the elopment of new policy and program proposals.

## 1972

Prompted by a realization of the need for a broadly coordinated approach to reduction of earthquake hazards, Governor Ronald Reagan appointed the vernor's Earthquake Council in January 1972. The council was designed to her all the forces concerned with earthquake research and preparedness in ifornia under a single banner. The council consists of 35 members and 30 ernates representing all levels of government, the universities, the private tor, and the general public.

The legislature's Joint Committee on Seismic Safety is formally represented the council and a number of members of the committee's advisory groups o serve on the council. The overlapping membership facilitates full cooper- on between the Joint Committee and the Earthquake Council, this being the licy of both.

The Earthquake Council was charged with advising the Governor on asures of any nature that should be undertaken to reduce future earthquake ses in California. The scope of their work is not restricted to recommending ion by State agencies only, but is meant to apply also to all entities with abilities in earthquake-related fields.

The organizational meeting of the Governor's Earthquake Council was held February 28, 1972. Its chairman, James G. Stearns, is a member of the vernor's Cabinet as Secretary for Agriculture and Services. The vice-chairman Herbert R. Temple, Jr., Director of the State Office of Emergency Services;

*See Appendix D for a further discussion of the subcommittee's report.

Wesley G. Bruer*, the State Geologist, until recently was secretary. The coun is guided by a nine-man Steering Committee consisting of the officers and o representative from each of the following: Federal agencies, State agenci universities, local governments, private organizations, and the public. Under t Steering Committee are the Preparedness and Response Committee and t Research and Investigation Committee, chaired by the council's vice-chairm and secreatry, respectively. At present, the life of the council is planned to r through June 1974.

The primary thrust of council recommendations is directly toward actio which may be taken administratively by all types of public and private entiti whereas the primary thrust of recommendations developed by the Joi Committee on Seismic Safety is toward State legislation.

## Activities of Other State Agencies

**Office of Architecture and Construction.** The State Office of Architectu and Construction (OAC) in the Department of General Services has seve functions related to earthquake safety. Since 1933 the Schoolhouse Sectio recently renamed the Structural Safety Section, has been enforcing t provisions of the Field Act which concerns itself with the earthquake resistan of specified public school buildings in California. Since the passage of Senate B 519 in the 1972 legislative session, this same section performs similar duties f hospital buildings under a contract with the State Department of Health. Th section continues to perform research on earthquake problems of structu significance. It also investigates the performance of structures following actu earthquakes and prepares building regulations relative to this subject as found Titles 17, 21, and 24 of the California Administrative Code.

Another primary function of OAC is to provide necessary architectural a engineering services to State departments and agencies for the complete desi and construction of buildings and other facilities. These facilities, of cours must be earthquake resistive.

OAC is also involved in post-disaster investigation and reporting, whether t disaster is caused by an earthquake or other forces. Acting on behalf of t Department of Finance and the State Office of Emergency Services, co formulas for use in Federal grants to local governments are recommended t accomplish repairs or replacement of damaged buildings, utilities, and oth facilities. Investigation in the field actually commences on the day of a disaste and damage assessment information is complied to assist the Governor determining the magnitude of the disaster. This information also helps determi the basis for requesting Federal aid under a Presidential declaration of a "maj disaster." Since the San Fernando earthquake of 1971, OAC has investigate inspected, and prepared reports on more than 2,000 claims, amounting to ov $275 million. Much additional work remains to be done.

**Office of Emergency Services.** The State Office of Emergency Services (OE is authorized by the Emergency Services Act (Chapter 7, Division 1, Title 2 the Government Code), which places OES within the Governor's Office.

* Left this position on October 31, 1973.

The act designates the OES director as the State Director of Civil Defense d State Emergency Planning, and further states that "during a state-of-war ergency, a state of emergency, or a local emergency, the Director shall ordinate the emergency activities of all state agencies in connection wtih such ergency." The act also charges OES to develop and maintain the State nergency Plan, which is the basis for State agency and local government ergency plans. OES is responsible for coordinating State agencies in the velopment of post-disaster damage assessments, including input received from al governments and the private sector. The responsibilities of OES are not ited to earthquakes.

**Division of Highways.** The Division of Highways in the State Department of blic Works is responsible for the operation of the State highway system, which ms the framework upon which the major portion of the State's vehicles vel. The division is thus under heavy obligation to maintain communications, en in times of disaster. Its objective, in this regard, is to reduce any traffic ruption and, in the event of a catastrophic disaster such as an earthquake or od, to restore traffic facilities—at least on a temporary basis—as soon as ssible.

**Department of Housing and Community Development.** The enabling thority for the State Department of Housing and Community Development (CD) may be found in the California Health and Safety Code and in the Labor de. In the area of earthquake-related activities, HCD is responsible for the velopment, interpretation, and enforcement of statewide building and housing ndards. HCD also works closely with other concerned State agencies in the velopment of building standards covering all types of occupancy.

**Department of Insurance.** The State Department of Insurance (DI) regulates urance companies transacting business in California, including those that offer thquake coverage, under authority granted in the Insurance Code. The gulatory functions of DI are to monitor the solvency of the companies oviding coverage to California policyholders, and to regulate the practices of ose companies as they affect the public interest. Specifically, in the area of thquake insurance, companies providing this coverage do so under a mpetitive system wherein the rates must (1) be adequate to ensure the mpanies' solvency, (2) not be unreasonably high for the coverage extended, d (3) treat like risks alike.

**Council on Intergovernmental Relations.** The State Council on Intergovernntal Relations (CIR) is most directly involved in earthquake-related activities ough the recently adopted amendment to the State Planning Law which quires that all cities and counties adopt seismic safety elements as part of their neral plans. CIR provides both technical and financial assistance to local vernments in the preparation of their general plans.

CIR distributed suggested interim guidelines for the seismic safety element—a prepared by the Governor's Earthquake Council—to all local governments in y 1972.

In order to provide more advanced guidelines for the preparation an content of seismic safety elements, CIR developed a demonstration project o this subject. A $66,000 grant was earmarked for a three-city seismic safet program which was conducted in 1972-73 by the cities of San Pablo, El Cerrit and Richmond, in western Contra Costa County. The California Division o Mines and Geology was to prepare the necessary geologic studies under contrac with these local governments.

**Division of Mines and Geology.** The responsibilities of the California Divisio of Mines and Geology (CDMG), in the Department of Conservation are a follows: (1) to represent the State's interest with regard to informatio pertaining to earthquake and other geologic hazards; (2) to conduct, with cit and county governments or Federal and other State agencies, large-scale geologi investigations whose purpose is to identify and delineate, on a timely basi geologic hazards in and adjacent to metropolitan areas; (3) to organize an monitor a strong-motion instrumentation program in the State, and (4) t quickly identify potential post-earthquake geologic hazards, particularly weak ened slopes, that could be activated by aftershocks.

CDMG's authority lies in the Public Resources Code. The agency's objectiv is to reduce loss of life and property due to earthquakes through the timel identification and delineation of earthquake hazards, and by providing ground motion response data useful in designing and building structures to resis earthquake damage.

**Office of Planning and Research.** The State Office of Planning and Researc (OPR), in the Governor's Office, is presently preparing a statewide plan an implementation program for protecting the State's land and water resource which are of statewide significance in terms of the State's natural resource bas and the preservation and enhancement of environmental quality as required b Government Code Section 65049. Among the areas to be covered are thos "which require special development regulation because of hazardous or specia conditions such as earthquakes fault zones, unstable slide areas, flood plains an watersheds."

**Department of Real Estate.** One of the functions of the State Department o Real Estate (DRE) is to administer the Subdivided Lands Act. This act provide in part, that a subdivider is required to give a copy of the subdivision publi report, prepared by DRE, to each prospective purchaser of a lot or parcel in subdivision. DRE, in this public report, discloses whether geologic conditions ar such as to constitute a hazard to the tract or any structures thereon.

To secure this information, DRE has entered into an agreement with CDM to review each subdivision filing and upon the completion of such review, t notify DRE whether a statement relative to geologic hazards should be include in the subdivision public report.

DRE's responsibility with regard to earthquake-related conditions is one o full disclosure to the first purchaser, or prospective purchaser, of a lot or parce in a subdivision.

**Department of Water Resources.** The State Department of Water Resources (DWR) is responsible for construction and operation of the State Water Project and for the safety of dams in California, other than those federally owned. Its authority for conducting earthquake-related investigations derives from this responsibility. The objective of these investigative programs is to acquire the data and develop the technology required to construct and maintain safe, economic, and reliable water-supply projects and to assure the safety of dams.

The Consulting Board for Earthquake Analysis, which was created in 1958, has continued to provide guidance in formulating and implementing a comprehensive program of seismological and earthquake engineering investigations. The board consists of five authorities representing the fields of seismology, geology, structural engineering, soil mechanics, and construction.

DWR's seismic investigations fall into three categories: (1) the identification and evaluation of earthquake-related hazards at sites for dams and water-supply facilities; (2) the study of seismic-related ground motions and deformations, and the response of superimposed structures; and (3) the design of dams and water-project facilities that will withstand earthquake effects.

DWR also sponsors a strong-motion seismograph program, which comprises 9 seismoscopes and 51 accelerometers. These instruments are located near facilities of the State Water Project; instrumentation has also been installed on structures of the project. This program was evolved to meet the requirements of analysis and design procedures which are an outgrowth of new knowledge about earthquakes and about the dynamic properties of materials. The instrument systems are triggered by a seismic event and record ground accelerations, dynamic stresses, and transient variations in hydraulic pressures.

# APPENDIX B: HISTORY OF EARTHQUAKE CODE PROVISIONS AND REGULATIONS IN CALIFORNIA

San Francisco was rebuilt after the earthquake and fire of April 18, 190 (Richter magnitude 8.3) under a code which specified, among other require ments, a basic 30 pounds-per-square-foot (psf) wind force on certain types o building to effect both wind and earthquake resistance.* Apparently the ter "earthquake" was not mentioned in this code. The specified wind load wa reduced to 20 psf in 1910 and to 15 psf in 1920. In the years that followed th 1906 earthquake, leading structural engineers employed the concept of latera earthquake forces proportional to mass or building weight, but this simpl concept did not find its way into the codes until 1927, when it was firs incorporated in the Uniform Building Code, and, more extensively, in 1933 following the Long Beach earthquake.

Originally, concerned cities, counties, State agencies, and technical associ ations developed various requirements directed toward the problem of effectin earthquake resistant design. Acting under State laws and/or local ordinances, o through individual effort, the various governmental entities approached th problem from somewhat different starting points, and consequently develope different lateral force requirements. As time went on, knowledge was gaine from research and from studies of actual earthquake damage; thus mutuall beneficial ideas were developed and exchanged between the code writing bodie and other interested groups. As a result of such activities, the lateral-forc provisions of later codes evolved along similar lines and are now basically th same, in general following the recommended lateral force requirements of th Structural Engineers Association of California (SEAOC).

Outlined below is a highlight history of earthquake codes in the State as see through the progress of several California cities, the State Chamber o Commerce, the Field Act, the Riley Act, Los Angeles County, the Uniform Building Code, the Fire Underwriters of the Pacific, SEAOC, the State Buildin Standards Commission, and the Applied Technology Council.

## Early Research †

In January 1925, the agency then known as the U.S. Coast and Geodeti Survey was directed to undertake studies in the field of seismology. Its work i this field was later continued under the National Oceanic and Atmospheri Administration (NOAA) until early 1973 when the latter's programs wer reassigned to the U.S. Geological Survey and the National Science Foundatio The first strong-motion earthquake recorder was developed in 1930, and sever

* Seismology Committee of the Structural Engineers Association of California *Recommended Lateral Force Requirements and Commentary,* 1967, pp. 30-3

† For additional detail see R. W. Binder, "Engineering Aspects of the 1933 Lon Beach Earthquake," in *Proceedings of the Symposium on Earthquake an Blast Effects on Structures,* Earthquake Engineering Research Institute an University of California (1952), pp.186 - 211.

o these were installed in Southern California during the summer of 1932. The s ong-motion record of the 1933 Long Beach earthquake, made by the i trument located in that area, was the first such record ever obtained for a n rby earthquake. Although the range of this instrument was exceeded, the r ord provided engineers with the first accurate measurement of a portion of t; strong-motion accelerations of a nearby moderate earthquake. Earthquakes h l, of course, been recorded previously; however, these were distant earthq akes detected by means of sensitive instruments. As of this writing, there is s l no seismic record of a great earthquake obtained with a strong-motion i trument located close to the epicenter.

Again in 1925, vibration experiments with simple structural models were f st made at the California Institute of Technology. In 1926, a pioneering s king table was constructed at Stanford University, and thereafter used for r ny important vibrational studies. During this period, also, California engineers v re discussing mutual earthquake engineering problems with engineers, r earchers, and university faculty members from Japan. Such an exchange of i ormation with other countries continues today through private correspond- e ce, periodicals, and books. Perhaps the most broadly beneficial exchange is t ough international conferences wherein all of the major current developments a; presented and discussed by representatives of the countries in which e thquakes pose a significant problem.

## nta Barbara and Palo Alto

Shortly after the Santa Barbara earthquake of June 29, 1925 (Richter i gnitude 6.3), the City of Santa Barbara adopted certain earthquake provisions i its municipal code. This was the first code in the State to incorporate r thquake provisions of any type. The City of Palo Alto added similar i quirements to its code a short time later. Both of these cities have now a opted the 1970 Uniform Building Code, which is generally based upon the r commended lateral force recommendations of SEAOC.

## ate Chamber of Commerce

In 1928, the California State Chamber of Commerce recognized the need for a building code which would be "dedicated to the safeguarding of buildings a inst earthquake disaster." It is interesting to note that the chamber launched t is project at the urgent request of business interests who were concerned about t e sharp recession in building, the increased costs of earthquake insurance, and t e amount of such insurance required by the State Corporation Commissioner b fore he would approve bond issues on certain types of structures following the 1 25 Santa Barbara earthquake. Studies made under the chamber's sponsorship i cluded work by many of the State's leading structural engineers, architects, a d building contractors, and resulted in a document entitled *Building Code for C lifornia,* which formed the foundation for the codes that followed. This c mprehensive code document, covering structural design as well as fire and s nic considerations, was published in 1939. No further work on building codes h s been done by the State Chamber of Commerce since that time.

## The Field Act

The Long Beach earthquake of March 10, 1933 (Richter magnitude 6.3 occurred at 5:54 p.m. on a Friday evening and destroyed or seriously damage many buildings in that area, including almost all of the public school building If the shocks had occurred during school hours, the probable loss of life amon school children would have been horrifying. Realizing that much of the loss an damage could have been avoided if the school buildings had been properl designed and constructed, the State legislature adopted the Field Act, Assembl Bill 2342, which was patterned somewhat after the State Dam Act of 1929. Th bill became Chapter 59 of the 1933 Statutes, and became effective as a emergency measure upon the signature of the Governor on April 10, 1933, month after the earthquake. The Field Act was made applicable only to publi school buildings and does not apply to the State colleges or universities, or t private schools.

The Field Act (Education Code Sections 15451 through 15465) assigned t the Division of Architecture in the State Department of Public Works th authority and responsibility, under the police power of the State, to pass upo and approve or reject plans and specifications, and to supervise the constructio of all public school buildings. It requires that an architect or structural enginee prepare the building plans and supervise the construction, and it require continual inspection of the construction by an officially approved inspecto employed by the school district. The act further required that the division adop building regulations as it deemed necessary and proper; it also contain provisions for the enforcement of the act. School buildings constructed unde the Field Act provisions have shown consistently high performance in all th earthquakes to which they have been exposed.

In 1933 the Division of Architecture adopted, practically in toto, th previously mentioned code developed by the State Chamber of Commerc These code regulations were commonly known as "Appendix A." They wer complete in their coverage and in part required that masonry buildings withou frames be designed for a lateral force of 10% of the sum of the dead load (th weight of the building) plus a portion of the live load. (A live load is usuall defined as the weight of a moving or movable load such as that of the building occupants and furnishings.) Other types of building construction were to b designed for 2% to 5% of the dead load, depending upon allowable soil pressure

In 1937 the division revised its lateral force design requirements to 6% - 10 of the dead load for buildings three stories or less in height, and for buildin without a moment-resistant frame. Buildings more than three stories high with complete moment-resistant frame required design coefficients of 2% - 6% provided the frame could resist 2% of the load. Again, the specified values wer related to the allowable soil pressures. In 1941 the coefficients specified were 6 - 10%, depending only upon the type of foundation materials used. Beginning i 1943 the division's regulations were published in Title 21 of the Californi Administrative Code (CAC). In 1953 new design criteria were adopted with th lateral-force coefficients based upon the formula: $C = 60/(N + 4.5)$, where N the number of stories above the one under consideration.

The rules and regulations adopted under the Field Act are complete; that i they include among their specifications allowable stresses for the variou

struction materials, maximum structural deflections, and the minimum thquake live load, and wind forces to be considered.

In 1965, under a State reorganization plan, the legislature reassigned the ies established by the Field Act to the Department of General Services. These ies continued to be performed by the same group, called the Schoolhouse tion of the State Office of Architecture and Construction in the Department General Services. This group is now called the Structural Safety Section and tinues to perform the assigned duties for public school buildings.

In recent years progress has been made in compiling and printing all State lding regulations in one document, Title 24 of the CAC, under the authority ted in the State Building Standards Commission. Under this program all of building regulations adopted by the Department of General Services rmerly Division of Architecture) pursuant to the Field Act have been nsferred to Title 24, called the "State Building Standards Code." Title 21 of C, on the other hand, contains the administrative regulations for the orcement of the Field Act and the materials testing requirements for struction covered by the act. It also repeats those building regulations in le 24 which are applicable to public school building construction. The ulations currently applying to public school buildings are those of the 1970 iform Building Code with certain necessary additions or amendments, as cited r under "State Building Standards Commission."

This group also performs the duties assigned to it through the enactment of ate Bill 519, Chapter 1130 of 1972. This bill, in general, requires a review of pital plans and construction somewhat similar to public school buildings. It o establishes a Building Safety Board to advise the Department of Health in enforcement of this bill.

## e Riley Act

After the Long Beach earthquake of 1933, the Riley Act, Assembly Bill 1 (Health and Safety Code, Sections 19100 to 19170), was adopted by the lifornia Legislature; it applied to buildings constructed after May 26, 1933. is legislation required that all buildings, except certain types of dwellings and m buildings, be designed for a lateral force of not less than 2% of the total tical design load.

In 1953 the lateral force requirement was revised to 3% of this load for ldings less than 40 ft high and 2% for those over 40 ft high. In 1965 the uired lateral force design values were again revised by the legislature to lect, by reference, those of Article 23, Part VI, Title 24 of CAC in effect at t time. These values were essentially the same as the ones specified in the 61 Uniform Building Code, and, in general, followed most of the recommen- ions of SEAOC.

## y of Long Beach

Twelve days after the Long Beach earthquake of 1933, the City of Long ach adopted emergency regulations to control masonry construction as a ult of the poor performance of, and large percentage of fatalities in, such ildings. The following day the city adopted another emergency ordinance quiring the owners of condemned buildings to demolish them.

On January 9, 1934, the City of Long Beach adopted Ordinance C-124 which specifically established requirements for seismic safety. The city has sinc adopted the 1970 Uniform Building Code with amendments.

### Los Angeles County

On March 20, 1933 the Los Angeles County Board of Supervisors adopte the City of Santa Barbara building ordinances which contained earthquak safety requirements. Because of the technical nature of the work, it was foun necessary to employ only licensed civil and structural engineers and certifie architects for the inspection tasks involved, and this in turn required a additional, implementing ordinance.

The Los Angeles County Coroner's Jury, evidently considering the Sant Barbara code inadequate, recommended the immediate adoption of the Unifor Building Code of the Pacific Coast Building Officials Conference, with certai strengthening modifications, for the construction and repair of all buildings i the county. Following similar recommendations by the School Committee of th 1933 Los Angeles County Grand Jury, the County Board of Supervisors on Apr 10, 1933 passed Ordinance Number 2236, adopting this code with certai amendments. Currently, Los Angeles County applies the 1970 Uniform Buildir Code with certain amendments.

### City of Los Angeles

On September 6, 1933, the City of Los Angeles published Ordinanc Number 62968 to provide the first seismic safety requirements in the L Angeles City Building Code. The code required a lateral force design coefficien of 8% of the sum of dead load plus half live load. This coefficient value was als specified in the 1935 Uniform Building Code for buildings resting upon soi capable of supporting 2,000 pounds, or more, per square foot in areas of highe seismicity, with double this value for buildings situated on weaker soils.

In 1943, the City of Los Angeles indirectly recognized the effect structural flexibility on the earthquake design coefficients and revised th required values to reflect the number of stories in a building according to th formula:

$$C = \frac{60}{N + 4.5}$$

where N = total number of stories in the building,
except N = 13 for buildings of 13 stories and less.

In 1972, the City of Los Angeles proposed a new concept in lateral forc requirements. It has to do with the use of considerably higher coefficient value which are closer to the actual earthquake forces measured by recorders, and related to current building design concepts. The direction is also toward more a dynamic type of analysis while retaining the current equivalent static criter for short-period, or low, buildings. As of this writing, the proposal has not bee adopted but is being studied by the various structural engineering profession societies and by industry. However, the city did make numerous revisions in th existing code in September 1972 following the recommendations of th

ctural Engineers Association of California and its own staff.

At present, the city of Los Angeles basically follows the requirements of the 0 Uniform Building Code, or those recommended by SEAOC for buildings than 160 ft high, and requires a dynamic type of analysis for buildings over ) ft in height.

### form Building Code

The first edition of the Uniform Building Code, published in 1927, tained a section on earthquake provisions in the appendix with the following amble:

> The following provisions are suggested for inclusion in the Code of cities located within an area subject to earthquake shocks. The design of buildings for earthquake shocks is a moot question, but the following provisions will provide adequate additional strength when applied in the design of buildings or structures.

The code then went on, basically, to suggest a lateral force design value of % of the sum of dead load plus live load, where the allowable soil pressure two tons, or more, per square foot. Where the allowable soil pressure was than this figure, lateral load design value was 10%.

Prior to 1961 the earthquake provisions of the Uniform Building Code were sented in its appendix only as "suggested" ordinances and not as mandatory uirements. This permitted local jurisdictions in the State, if they so desired, exclude the appendix when adopting the code, and to apply only the rather imal requirements of the Riley Act. In 1961 the lateral force provisions were luded in the main body of the Uniform Building Code, and were revised to ee with the recommended lateral force requirements of SEAOC.

### ard of Fire Underwriters of the Pacific

Although not constituting a building code per se, the recommendations olished in 1935 by the Board of Fire Underwriters of the Pacific dealt with design of earthquake-resistant buildings that might be covered by earthquake urance. These recommendations followed the general patterns already cribed.

### y of San Francisco

It wasn't until 1947 that San Francisco had any seismic safety requirements re stringent than those of the Riley Act in its code. In that year a table of eral-force coefficient values was adopted. The required design values ranged m a maximum of 8% for single-story buildings down to a minimum of 3.7% those 30 stories high, with variations for different soil conditions. These efficient values applied to the vertical design loads.

The city's action prompted the formation, in 1948, of a Joint Committee on teral Forces, comprised of representatives of the San Francisco Section of the nerican Society of Civil Engineers and the Structural Engineers Association of rthern California. This committee, after several years study, recommended a de in which the coefficient values were related to the estimated or calculated

fundamental period of vibration (a vibrational characteristic) of the structure a follows:

$$C = \frac{K}{T}$$

where K = 0.015 for buildings, and 0.025 for other structures
T = period of vibration in seconds.

For buildings, the maximum and minimum specified coefficient values wer 6% and 2% respectively; for other structures, the corresponding values were 10% and 3%. These coefficient values were usually applied to the sum of dead loa plus 25% of live load, or 50% of live load in the case of storage or warehous buildings.

In 1956 San Francisco adopted the Joint Committee's formula, but wit somewhat different parameter values as follows: K = 0.02 for buildings an 0.035 for other structures. In addition, the maximum and minimum coefficien values specified for buildings were 7.5% and 3.5% respectively; for othe structures, the corresponding values were 10% and 4%. Since 1962 the city ha followed the recommended lateral force requirements of SEAOC with certai exceptions, generally relating to ductile frame requirements.

### Structural Engineers Association of California*

In 1957 the Structural Engineers Association of California assembled fro among its members a statewide Seismology Committee, which was assigned th task of resolving differences in existing building codes and preparing a single se of recommendations for lateral-force criteria to be used in the design o earthquake-resistant buildings in California. These recommendations were firs published in July 1959 as *Recommended Lateral Force Requirements an Commentary*, after much deliberation, and have since been adopted by man code writing and enforcement agencies throughout the world.

The primary problem with writing lateral-force provisions into buildin codes is that the basic knowledge relevant to the subject is still limited at th time, and the recommendations provided represent merely the current state-o the-art. However, the SEAOC recommendations do take into account th flexural and dynamic or vibrational characteristics of different types c structures.

Several updating revisions have been made to the recommendations base upon research information and investigations of structures exposed to earth quakes. The association realizes, nonetheless, that its recommendations need general revision to reflect currently available information. The latest revisio were issued as Appendix F to the original document and, in general, represent stopgap effort to include some of the current state-of-the-art knowledge o earthquake engineering which has been confirmed as valid by the 1971 Sa Fernando earthquake.

* For additional detail see R. W. Binder and W. T. Wheeler, "Building Cod Provisions for Aseismic Design" in *Proceedings of the Second Worl Conference on Earthquake Engineering* (Tokyo, 1960), Vol. 3, pp. 1843-60.

The main thrust of further revisions will probably be in the direction of making orderly changes in the lateral-force recommendations and expanding the provisions to include decorative features and mechanical and electrical systems. As more research is performed and more information becomes available, future building codes will undoubtedly recognize more directly the physical properties and dynamic characteristics of, and interactions among, the various elements of the seismic equation: the earthquake, the soils, the structure, and the contents of the structure.

### State Building Standards Commission

In 1953 the State Building Standards Law was enacted (Sections 18900 - 19917 of the Health and Safety Code) to establish the State Building Standards Commission and to adopt and publish a single State building code compiled from regulations adopted by the various State agencies. Its purpose was to eliminate conflict, duplication, and overlap in State building regulations.

The adopted State code is published in Title 24 of the California Administrative Code (CAC). In 1963 the lateral-force requirements of the 1961 Uniform Building Code and the recommendations of SEAOC were adopted and published in Title 24, CAC. In December 1971, following a mandate by the legislature to adopt model codes by reference, the 1970 Uniform Building Code was adopted by reference as the basic regulations in Part 2 of Title 24, CAC. Exceptions to these basic regulations for public school buildings and other State building occupancies are published in Part 6 of Title 24, CAC.

### Applied Technology Council

In 1971 the Board of Directors of SEAOC authorized the formation of the Applied Technology Council (ATC), a non-profit corporation, and charged it with implementing current technological developments into active structural engineering practice so that recent research by universities and other researchers might be applied for the greatest benefit of the general public. This council, appointed from nominations of the four California structural engineers associations, has had contracts with both the National Science Foundation and the National Bureau of Standards to perform preliminary work relative to the rewrite of the seismic provisions of building codes. Currently, contracts have been signed leading to the complete rewrite of these code provisions.

### Earthquake Engineering Research Institute

Although this group specifically avoids direct involvement in preparing building regulations, the data obtained and efforts put forth by the institute are directly applicable to code preparation. This is evidenced by its participation in international conferences on earthquake engineering, its investigations and reports on all aspects of this subject following actual earthquakes throughout the world, and other earthquake engineering related projects.

## APPENDIX C: GEOLOGIC AND SEISMOLOGIC FEATURES OF EARTHQUAKES

California is earthquake country! This is abundantly clear from the 200-yea record since Gaspar de Portola reported a strong earthquake near the Santa An River in Orange County in 1769. Of the thousands of felt earthquakes durin these two centuries, at least 3—Fort Tejon 1857, Owens Valley 1872, and Sa Francisco 1906—were truly *great* earthquakes (Richter magnitude greater tha 7.7); at least 12—like Arvin-Tehachapi 1952, and El Centro 1940—were *majo* earthquakes (magnitude 7.0 to 7.7); and over 60, such as Santa Barbara 192 Long Beach 1933, and San Fernando 1971, were *moderate* shocks (magnitud 6.0 to 6.9). In addition, about 200 earthquakes per decade in the magnitud range of 4.0 to 5.9 have been strongly felt locally. Some have produced no rea damage; others (1969, Santa Rosa) have produced rather significant damage.

Long as it is, compared to the average human life, this earthquake recor does not constitute a statistically sound basis for predicting the seismicity of th State for the next several hundred years. However, the record is reinforced b extensive geologic evidence of faulting during the past million years. An wherever there has been active faulting, earthquakes have occured. These data and other seismologic and geologic reasoning, lead to the conclusion tha California should anticipate a *great* earthquake about every 60 to 100 years, *major* earthquake on an average of about every 20 years, and *moderat* earthquakes on an average of perhaps every 8 to 10 years. As far as we know however, no regular periodicity can be expected and precise earthquak prediction is not yet possible.

In what parts of California are damaging earthquakes most likely to occur Are there any areas which are "safe" from earthquakes? Figure C-1 and Tabl C-1, taken together, give a general picture of the surface-faulting condition o the State. However, construction of a seismic-risk map of the State, which woul outline areas of differing susceptibility to earthquake damage, is fraught wit difficulties. There are too many parameters which are imperfectly known o understood. Distance from the earthquake epicenter; characteristics of the rock earth, or soil; depth of focus of the earthquake; location with respect to a active fault; magnitude of the earthquake; and duration of ground shaking—al are important factors influencing the extent of damage from a given earthquake However, given a moderate-to-great earthquake, the most important factor affecting damage to property and loss of life are the density of population an the type of building construction. Obviously, it is our great metropolitan center that are most vulnerable, and the poorly built works of man in such areas will b the sources of injury, death, and property loss (See Table C-2).

Any major or great earthquake is usually felt over an area as large as th entire State of California (about 156,000 square miles). For example, Arvin Tehachapi 1952 (magnitude 7.7) was felt over 160,000 sq mi; San Francisc 1906 (magnitude 8.3) was felt over 375,000 sq mi. With our present state o knowledge, it must be concluded that no part of California may be considere immune from earthquake damage. Nevertheless, there are parts of the Stat where low population, solid bedrock near the earth's surface, and a relatively large distance from known active faults appear to reduce earthquake hazards o

suctures with certain dynamic properties to a minimum.

The following is a brief discussion of some of the geologic effects ecountered in moderate-to-great earthquakes.

## lound Motion

In a moderate-to-great earthquake, ground motion is intense enough within a w miles of the epicenter to make it difficult for an adult to stay on his feet. ere is strong motion lasting a few seconds in a moderate earthquake to as uch as 4 minutes in a great earthquake. There is exaggerated motion on loose, ter-saturated ground; less on solid rock. In great earthquakes, there is long, ongly-felt, swaying ground motion up to 80 miles from the epicenter. perience in the San Fernando earthquake of 1971 showed again that local tensities—ground acceleration—may be as large in a moderate earthquake as in great earthquake, but the latter lasts longer and affects a larger area.

## rface Faulting

In a moderate earthquake, fault rupture along a rough plane in rock at erage depths of 3 - 10 miles may or may not extend to the surface. Most, if t all, moderate California earthquakes have been accompanied by surface ulting (see Table C-1 and Fig. C-1). Surface faulting develops scarps, graben enches), fractures, and "mole tracks" or pressure ridges. Spasmodic slippage reep) occurs along many active faults, with and without earthquakes. The nse of fault movement may be right-lateral, left-lateral, reverse, normal, or lique slip (see Fig. C-2).

All of the great earthquakes in California have been accompanied by several et of surface fault displacement, as indicated in Table C-1. Complex fault acturing occurs within a half-mile wide zone with dislocation of drainage atures and ground water. There is a tendency toward surface faulting along the me fault plane in subsequent earthquakes, although fault fractures are not nfined to such a plane. Displacement along nearby faults may also be iggered.

## round Failure

Earthquakes generally produce various types of ground failure. These clude: landslides and liquefaction of sand layers; fracturing, cracking, and ssuring; and compaction, subsidence, and uplift.

**Landslides and Liquefaction.** Mass movements of loose rock, soil, and ater-saturated, weathered materials are major effects in all earthquakes large nough to be felt. They consist of rock falls, landslides, rock avalanches, mud nd debris flows, and all other types of gravitational earth movement from very inor slides to those involving millions of cubic yards. Steep slopes favor such nass movements but "liquefaction" of fine sandy sediments may lead to failures n low slopes (see Fig. C-3). That is why slides occur so frequently in highway uts and downhill road shoulders. High rainfall and saturation by water are also onducive to mass earth movements.

In a great earthquake, there are usually large mass movements of rock and earth over wide areas, and many hundreds of landslides. There is severe landslide damage, particularly to highways, up to 75 miles, or more, from the epicenter. In addition, aftershocks may trigger successive slides for weeks or even months after a major or great earthquake. Rock fragments and boulders are moved downslope, and all main roads in hilly and steep areas are likely to be closed for hours to days after the earthquake. There are mass movements of earth, rock and pavement at bridges and overpasses; repaired movements may relapse with aftershocks. Old landslides in fault zones may be reactivated. Although ground water saturation favors gravity-propelled movements of earth and rock, sliding also occurs in dry materials. Inadequately compacted fill, and fill placed over weak materials are particularly susceptible to sliding.

**Fracturing, Cracking, and Fissuring**. Ground shaking, settling, compaction of earth, and sliding produce irregular fractures, cracks, and fissures from a few inches to many feet in length. This is characteristic of all earthquakes large enough for significant ground motion to occur. Such fractures may displace soil and earth in a manner similar to faults. Fractures are rare in solid rock; most significant in weathered rock, alluvium, and soil.

Fracture patterns may be controlled by shallow bedrock structures, by highway surfacing, and by the margins of fill, and engineering structures. Fractures are often accompanied by sand boils and mud "volcanoes"—evidence of liquefaction. Fracturing may cause damage up to several miles from the epicenter.

These effects are augmented and accented in great earthquakes. Extensive fissuring and lurch cracking may occur in weak soil and alluvial basins up to 75 -80 miles, or more, from the epicenter. There is evidence to indicate that such fracturing is more extensive in the deeper alluvial materials. Another effect is the extensive rippling and fracturing of pavements and curbs. In addition, many fractures, straight or curving, will offset soils and structures in a way similar to faulting.

**Compaction, Subsidence, and Uplift**. Compaction of soils and alluvium, particularly as a result of shaking, occurs irregularly and may be partly oriented by bedrock surfaces, and old lake, slough, swamp, and stream beds. The amount of compaction may range from a few inches to several feet. Irregular compaction is most widespread and extreme in great earthquakes. It may occur as much as 75 - 80 miles, or more, from the epicenter and may amount to several feet even at that distance.

Tectonic subsidence, uplift, tilting, and warping may occur over several square miles in larger earthquakes. Tectonic movements of great importance may occur over hundreds or even thousands of square miles in great earthquakes. Ground warping may amount to as much as several feet of horizontal or vertical differential. Significant secondary faulting may take place in the uplifted or arched blocks. Such movements become most noticeable near the shorelines of bays, seas, and lakes.

In sizable earthquakes, groundwater and surface water regimens are also widely disrupted.

## Seismic Sea Waves and Seiches

Seiches, or periodic oscillations ("sloshing") of bodies of water such as ponds, lakes, and bays usually occur in moderate-to-great earthquakes. Seiches may raise and lower a water-surface by anywhere from a few inches to several feet, and may occur as much as several thousand miles away from the epicenter of a major or great earthquake.

The seismic seawave, or tsunami ("tidal wave"), is a wave which moves at velocities of 300 - 400 miles per hour, and may be many miles long in deep open water. Approaching the shore, at a slow speed, the wave may reach a height of 50 ft.

There is no record of any seiches or tsunamis more than a few feet high occurring in the State, but major-to-great Pacific Ocean earthquakes have caused damage along the California coast. Twelve people lost their lives in a tsunami affecting Crescent City at the time of the Alaska earthquake of 1964, and there was minor damage along the California coast at the time of the 1960 earthquake in Chile.

**Table C-1. Notable Earthquakes Along California Faults.[1]**

| Year of Occurrence | Fault | Richter Magnitude | Ground Movement |
|---|---|---|---|
| 1836 | Hayward | 7.0 ± 0.5 (est.) | Ground breakage |
| 1838 | San Andreas | 7.0 ± 0.5 (est.) | Ground breakage |
| 1852 | Big Pine | N.A.[2] | Ground breakage |
| 1857 | San Andreas | 8.0 ± 0.5 (est.) | Right-lateral, possibly as much as 30 ft |
| 1861 | Calaveras | N.A.[2] | Ground breakage |
| 1868 | Hayward | 7.0 ± 0.5 (est.) | Strike slip |
| 1872 | Owens Valley (fault zone) | 8.3 ± | Downfaulted on the E, 23 ft; right lateral, 16 - 20 ft (some reports state left lateral movement also occurred) |
| 1899 | San Jacinto | 6.6 ± 0.42 | Surface evidence questionable |
| 1901 | San Andreas | 6.3 ± 0.42 | Ground breakage |
| 1906 | San Andreas | 8.3 | Right-lateral, 21 ft |
| 1922 | San Andreas | 6.5 | Ground breakage |
| 1934 | San Andreas | 6.0 | Ground breakage |
| 1934 | San Jacinto (fault zone in Colorado River Delta) | 7.1 | Distinct fault trace on 1935 aerial photographs |
| 1940 | Imperial | 7.1 | Right-lateral, 19 ft |
| 1947 | Manix | 6.4 | Left-lateral, 3 in. |
| 1950 | Unnamed fault along west edge of Fort Sage Mountains | 5.6 | Downfaulted on the W, 5 - 8 in. |
| 1951 | Superstition Hills | 5.6 | Right-lateral, slight |
| 1952 | White Wolf | 7.7 | Reverse fault, south plate moved from SW to NE; left-lateral, 2 ft; throw 2 ft |
| 1956 | San Miguel | 6.8 | Right-lateral, 3 ft; SW block down 3 ft |
| 1966 | Imperial | 3.6 | Right-lateral, 1.5 cm |
| 1966 | San Andreas | 5.5 | Right-lateral, several inches |
| 1968 | Coyote Creek (San Jacinto zone) | 6.5 | Right-lateral, 33 cm |
| 1971 | San Fernando | 6.6 | Left-lateral, 6 ft; reverse 6 ft |

[1] The location of the fault is shown in Fig. C-1.

[2] Not available.

| | | | | | |
|---|---|---|---|---|---|
| 1769 | Orange County (Portola expedition camped near Olive) | Unknown | 0 | Unknown | First earthquake recorded in California history |
| 1812 | San Juan Capistrano (unknown fault) | 7-8[3] | Over 50 | Severe damage to missions at San Juan and Santa Ynez | Missions are 160 miles apart |
| 1836 | Hayward (Hayward fault) | 7[3] | 0 | Few structures damaged | Surface faulting from Mission San Jose to San Pablo |
| 1838 | San Francisco Peninsula (San Andreas fault) | 7[3] | 0 | Few structures damaged | Surface faulting from Mission Santa Clara to San Francisco |
| 1852 | Lockwood Valley, Ventura County | 7[3] | 0 | Few structures damaged | Fissures 30 miles long in Lockwood Valley area |
| 1857 | Fort Tejon (San Andreas fault) | 8[3] | 1 | Fort damaged; other structures unknown | Shaking felt over 400,000 sq mi; surface faulting 225 miles from Cholame to San Bernardino; max. right-lateral displacement 30 ft |
| 1865 | San Francisco-San Jose | 7[3] | None known | Severe damage to buildings in San Francisco, San Jose and Santa Clara ($500,000) | Probably surface breaking on San Andreas fault |
| 1868 | Hayward (Hayward fault) | 7[3] | 30 | $350,000 | Surface faulting from San Leandro Creek to Warm Springs; max. right-lateral displacement 3 ft |

Table C-2 — *Continued*

| Year | Location | Richter Magnitude | Lives Lost | Property[2] Damage | Comments |
|---|---|---|---|---|---|
| 1872 | Owens Valley | 8.2+[3] | 27[4] | 52 of 59 adobe buildings in Lone Pine destroyed $250,000; damage to State Capitol in Sacramento | Surface faulting for 100+ miles from Haiwee to Bishop; Sierran block up 23 ft at Lone Pine; max. right-lateral component 16 ft; shaking over area of 640,000 sq mi |
| 1890 | Monterey Bay, near Chittenden Pass (San Andreas fault) | 6.5[3] | 0 | Railroad track and bridge displaced in Chittenden Pass; road closed by landslides on trace of San Andreas fault; Anzar Lake drained by fractures | Surface faulting in Chittenden Pass; shaking felt from Salinas to Santa Rosa |
| 1892 | Vacaville (unknown fault) | 6+[3] | 1 | Damage centered in Vacaville-Dixon-Winters area (about $250,000) | Ground ruptures at Vacaville; shaking felt from San Francisco to Reno, Fresno and Red Bluff; damage reported in Sacramento |
| 1898 | Mare Island (unknown fault; possibly Hayward) | 6.5[3] | Note[5] | Congress appropriated $350,000 for repairs in Mare Island Navy Yard; additional damage in San Francisco Bay area: $1,400,000 | Earthquake duration in San Francisco and Mare Island 40 sec. |
| 1899 | San Jacinto | 7[3] | 6 | Damage in San Jacinto, Hemet, San Bernardino, and Riverside | Ground ruptures and sinks in San Jacinto fault zone southeast of San Jacinto; shaking felt over 100,000 sq mi |
| 1901 | Stone Canyon, Monterey County | 6.5[3] | 0 | Few structures damaged | Surface cracks hundreds of feet long in or near |

| | | | | | |
|---|---|---|---|---|---|
| | center on San Andreas fault near Olema at south end of Tomales Bay) | | 1300 | and following fire totaled about $1 billion; damage to all structures and extreme damage to trees in forest near Loma Prieta where J.C. Branner of Stanford University counted 345 ground cracks in zone 200 ft wide and 1 mi long; main 3-ft pipe from San Andreas Lake to San Francisco broken cutting off city water supply. Intensified damage and ground breakage in Santa Rosa Valley and in alluvial areas in San Francisco and Bay margins. | from San Juan Bautista to Shelter Cove in Humboldt County; max. right-lateral displacement 20-21 ft near Olema; minor vertical components locally; duration 40 sec. in San Francisco; shaking felt over 375,000 sq mi from Coos Bay, Oregon to Los Angeles and east to central Nevada |
| 1910 | Chittenden Pass (San Andreas fault) | 7[3] | 0 | Minor | Shaking felt over 50,000 sq mi but local intensity not high; deeper focus than normal |
| 1911 | Coyote (Calaveras fault) | 6.6[3] | 0 | Damage at Lick Observatory, Mt. Hamilton; damage from Gilroy to San Francisco | Shaking felt over 60,000 sq mi |
| 1915 | Imperial Valley (epicenter near El Centro; Imperial fault) | 6-7[3] | 6 | $900,000 | Shaking felt over 50,000 to 100,000 sq mi |
| 1918 | San Jacinto-Hemet (San Jacinto fault) | 7[3] | 1 | $200,000, mostly in San Jacinto | Shaking felt over 150,000 sq mi; largest earthquake in California since 1906; 10 mi fractures on fault trace, but little evidence of relative movement |

Table C-2 — *Continued*

| Year | Location | Richter Magnitude | Lives Lost | Property[2] Damage | Comments |
|---|---|---|---|---|---|
| 1922 | Cape Mendocino, at sea (Mendocino Escarpment) | 7.5+[3] | 0 | Minor damage at Eureka | Shaken area about400,000 sq mi; probably a great earthquake centered 90 mi west of Eureka |
| 1922 | Cholame Valley (San Andreas fault) | 6[3] | 0 | Damage at Cholame, Parkfield and San Luis Obispo | Shaking felt over 90,000 sq mi |
| 1923 | San Bernardino (possibly San Andreas fault) | 6[3] | 0 | Small | Shaking felt over 70,000 sq mi |
| 1925 | Santa Barbara (fault in Santa Barbara Channel) | 6.3 | 13 | $8,000,000, mostly in Santa Barbara business district | Shaking felt over 100,000 sq mi |
| 1932 | Humboldt County (offshore; possibly Gorda Ridge) | 6.4 | 1 | Small | Effect strongest at Arcata |
| 1933 | Long Beach (Newport-Inglewood fault; epicenter offshore at Newport Beach) | 6.3 | 115 | Major damage in Compton and N. Long Beach ($60,000,000) | Many school buildings destroyed; Field Act passed after earthquake |
| 1940 | Chico (fault unknown) | 6.0 | 0 | Unknown | Shaking felt over 28,000 sq mi |
| 1940 | Imperial Valley, or "El Centro" earthquake | 7.1 | 9 | $6,000,000 | Right-lateral displacement on Imperial fault along 32 mi trace, max. 19 ft at All-American canal; this earthquake used as a standard by structural engineers |
| 1941 | Owens Valley (Sierra Nevada fault zone) | 6.0 | 0 | Minor | Two strong shocks felt over 36,000 sq mi, a few minutes apart |

| | | | | | |
|---|---|---|---|---|---|
| | Barbara Channel fault) | | | | |
| 1941 | Torrance-Gardena | 6.5± | 0 | $1,000,000 | |
| 1941 | Eureka (offshore, Gorda Escarpment) | 6.4 | 0 | Minor damage at Eureka | Shaking felt over 12,000 sq mi |
| 1942 | Lower Borrego Valley | 6.5 | 0 | Minor; few structures involved | |
| 1946 | Walker Pass (fault unknown) | 6.3 | 0 | Essentially none | |
| 1947 | Manix | 6.4 | 0 | Essentially none | Surface faulting; max. left-lateral 3 in. |
| 1948 | Desert Hot Springs (probably Mission Creek fault in San Andreas fault zone) | 6.5 | 0 | Essentially none | |
| 1948 | Verdi, Nevada[7] (Verdi fault) | 6.0 | 0 | Essentially none | Shaking felt over 40,000 sq mi, strongly in California |
| 1949 -1961 | Terminal Island - Wilmington | Low | 0 | Total of $20,000,000 to oil wells in Wilmington Field | Series of small earthquakes due to slippage along bedding planes, associated with subsidence due to withdrawal of oil and gas |
| 1950 | Herlong (Ft. Sage Mountain fault in E. Sierra Nevada fault zone near Honey Lake) | 5.6 | 0 | Essentially none | Normal fault trace 6 mi long, down to W.; max. 8 in. |

Table C-2 — *Continued*

| Year | Location | Richter Magnitude | Lives Lost | Property[2] Damage | Comments |
|---|---|---|---|---|---|
| 1952 | Arvin-Tehachapi (Kern County) | 7.7 | 14 | $55,000,000, mostly in Kern County but also in Los Angeles, Long Beach, Pasadena and Santa Barbara (includes S. San Joaquin Valley agricultural losses of over $23,000,000 in crops, re-leveling, pipes, ditches, reservoirs) | Shaking felt over 160,000 sq mi; surface faulting on left-lateral reverse White Wolf fault for about 40 mi; max. vertical displacement 2 ft, horizontal 2 ft; three aftershocks above magnitude 6 |
| 1954 | Eureka-Arcata (unknown fault) | 6.5 | 1 | $2,100,000 | Shaking felt over 50,000 sq mi |
| 1957 | San Francisco (San Andreas fault near Mussel Rock) | 5.3 | None[8] | $1,000,000 to homes in Daly City area; State Highway 1 closed by slides and permanently re-routed | Shaking felt over 13,000 sq mi; small earthquake but strongest felt in San Francisco since 1906 |
| 1960 | Chile | 8.6 | None in California | Tsunami caused damage along west coast of California, $500,000 | A great earthquake originating under the margin of the Pacific Ocean |
| 1964 | Alaska | 8.5 | 11 at Crescent City, Calif. | Tsunami caused damage along California coast; $11,500,000 at Crescent City | A great earthquake originating under the margin of the Pacific Ocean in the Aleutian Trench |
| 1966 | Parkfield (San Andreas fault) | 5.5 | 0 | Small | Surface faulting at Cholame-Parkfield for over 20 mi; max. right-lateral displacement of a few inches; max. acceleration 0.5 g |

| | | | | | |
|---|---|---|---|---|---|
| 1968 | Borrego Mountain (Coyote Creek fault in San Jacinto fault zone) | 6.5 | 0 | Minor; few structures involved | Right-lateral displacement along 20 mi trace, max. 8 in. |
| 1969 | Santa Rosa (epicenters on SE projection of Healdsburg fault) | 5.6, 5.7 | 0 | $10,000,000 in Santa Rosa; anomalous damage pattern in this deeply alluvial valley; unusually high damage considering the earthquake magnitude | Two small earthquakes but strongest in Santa Rosa Valley since 1906; no surface faulting; focal depths about 6 mi; right-lateral slip on near-vertical fault plane |
| 1971 | San Fernando | 6.4 | 58 | $500,000,000 | |

[1] Some earthquakes of less than moderate magnitude (Richter 6.0-6.9) are included because they produced substantial property damage or significant earth movement. Also included are some that occurred outside the State but resulted in property damage and/or loss of life in California.

[2] Figures given are estimated total losses in dollars valued at the time of occurrence.

[3] Preceded development of scale and represents best scientific judgement.

[4] Loss of life occurred at Lone Pine (pop. 250).

[5] Loss of life described as "small."

[6] Total deaths were 500-1000 in San Francisco and another 300 outside the city.

[7] City is at California-Nevada border.

[8] Earthquake resulted in 40 minor injuries.

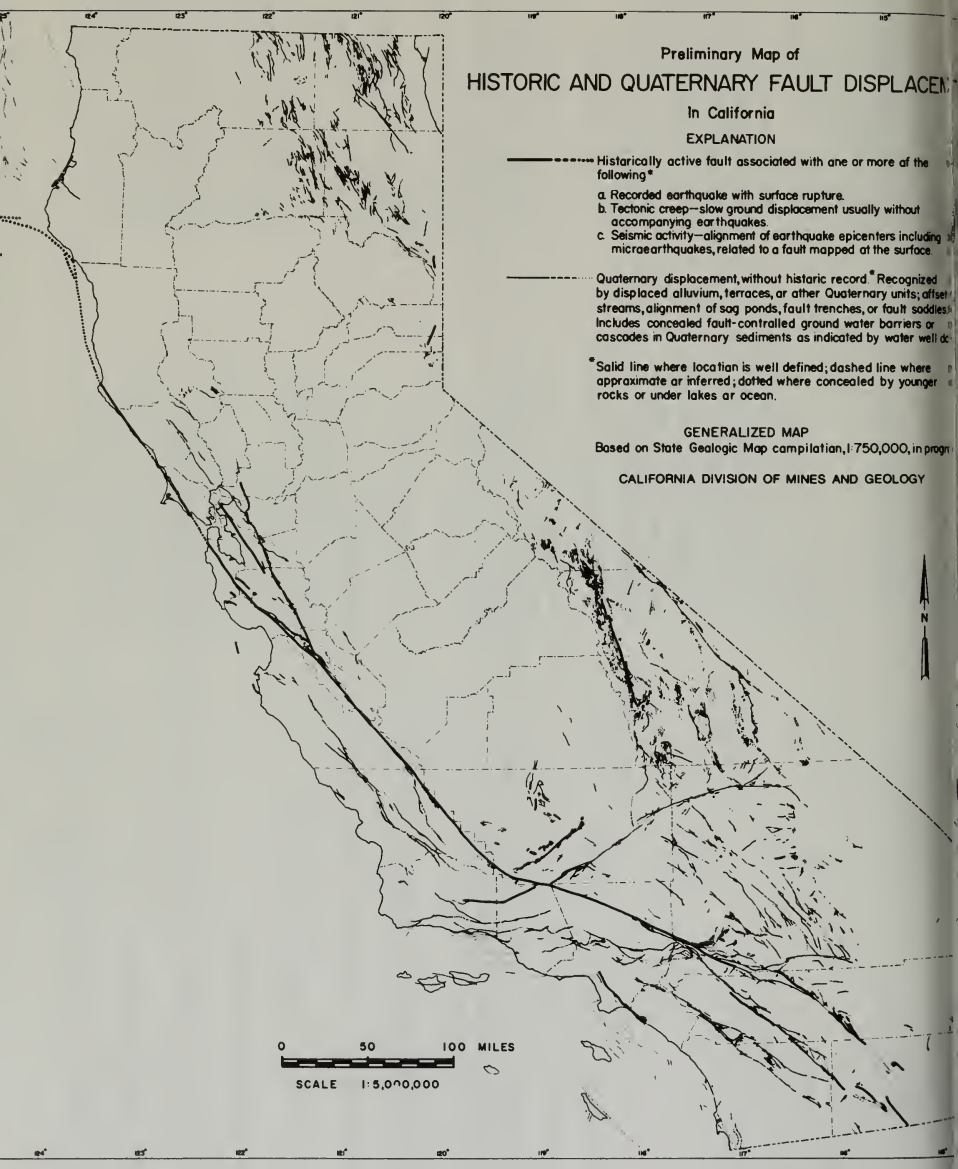
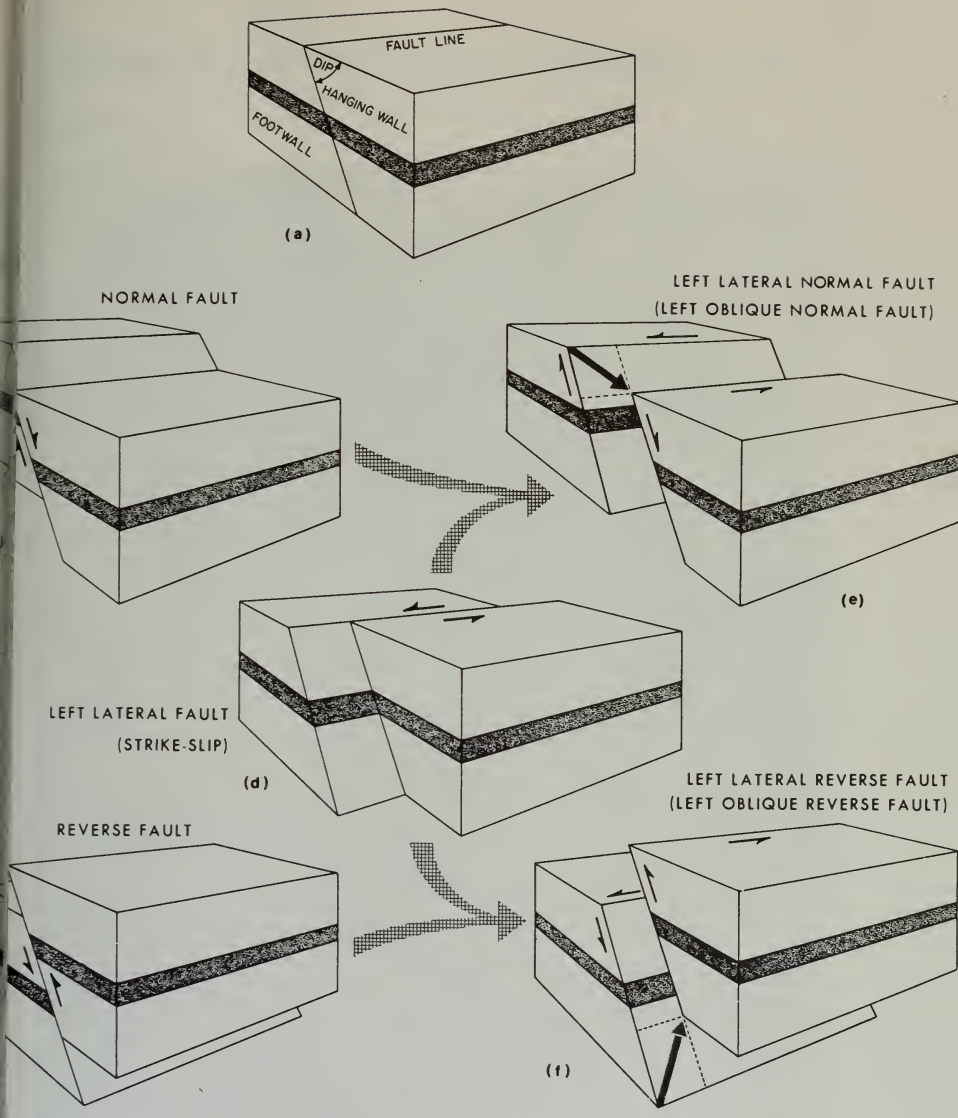

Preliminary Map of
HISTORIC AND QUATERNARY FAULT DISPLACEM
In California
EXPLANATION
Historically active fault associated with one or more of the following*
a. Recorded earthquake with surface rupture.
b. Tectonic creep—slow ground displacement usually without accompanying earthquakes.
c. Seismic activity—alignment of earthquake epicenters including microearthquakes, related to a fault mapped at the surface.
Quaternary displacement, without historic record* Recognized by displaced alluvium, terraces, or other Quaternary units; offset streams, alignment of sag ponds, fault trenches, or fault saddles. Includes concealed fault-controlled ground water barriers or cascades in Quaternary sediments as indicated by water well data
*Solid line where location is well defined; dashed line where approximate or inferred; dotted where concealed by younger rocks or under lakes or ocean.
GENERALIZED MAP
Based on State Geologic Map compilation, 1:750,000, in progress
CALIFORNIA DIVISION OF MINES AND GEOLOGY
N
0 50 100 MILES
SCALE 1:5,000,000

**Fig. C-1. Location of principal active faults in California.**
*California Division of Mines and Geology.*




2. Types of fault movement. a) Names of some of the components of faults. b) Normal fault, in the hanging wall has moved down relative to the foot wall. c) Reverse fault, sometimes called fault, in which the hanging wall has moved up relative to the foot wall. d) Lateral fault, mes called strike-slip fault, in which the rocks on either side of the fault have moved sideways ch other. It is called *left* lateral if the rocks on the other side of the fault have moved to the observed while facing the fault and *right* lateral if the rocks on the other side of the fault have to the right, as observed while facing the fault. e) Left lateral normal fault, sometimes called a lique normal fault. Movement of this type of fault is a combination of normal faulting and left faulting. f) Left lateral reverse fault, sometimes called a left oblique reverse fault. Movement of pe is a combination of left lateral faulting and reverse faulting. Two types of faults not shown ilar to those shown in e and f. They are a *right* lateral normal fault and a *right* lateral reverse a right oblique normal fault and a right oblique reverse fault, respectively).

*California Geology, November 1971.*

**Liquefaction of fine sandy sediments may lead to failure.**
*K. V. Steinbrugge collection.*

# APPENDIX D: THE SAN FERNANDO EARTHQUAKE STUDY

## Origin and Purpose

After the San Fernando earthquake of February 9, 1971, the California Legislature's Rules Committee, by means of Resolution 7, asked the Chairman of the Joint Committee on Seismic Safety to appoint a special three-man subcommittee to conduct an in-depth investigation of the effects of that earthquake and to report its findings*. Senator Alquist appointed Assemblyman James A. Hayes chairman of the subcommittee. Other members were Senator Joseph M. Kennick and Assemblyman Jim Keysor.

The primary objective of the study was to examine and evaluate the effects of the earthquake so as to learn what public policies are needed to minimize injury, loss of life, damage to structures, and disruption of the economy from future destructive earthquakes occurring anywhere in the State.

## Major Effects of the Earthquake

The characteristics, timing, and effects of the San Fernando earthquake provided a good opportunity for such a study. Associated with the earthquake, which was moderate (6.4) in terms of magnitude, were ground breakage along the San Fernando fault (as much as 6 ft horizontally and 6 ft vertically), strong ground shaking, and ground failures (cracking, liquefaction, and landslides), all of which caused substantial damage to man-made structures (a total of more than $500,000,000) and 58 deaths.

**Damage to Buildings.** Five percent of the 300,000 family dwellings in the area of strong shaking were damaged in varying degrees; of these, 465 were declared unsafe and evacuated. These homes were concentrated in the zone of ground breakage along the San Fernando fault and in areas of stiff shallow soils.

A total of 62 apartment houses and 372 commercial structures were so severely damaged that they had to be evacuated.

The earthquake was very destructive to old, reinforced masonry buildings, not only in the area of strong shaking but also in adjacent older communities, including downtown Los Angeles, 15 to 25 miles from the epicenter.

High-rise buildings received only a partial test. They were located 10 to 25 miles from the center of the earthquake and behaved well structurally. There was, however, considerable non-structural damage—cracking of interior partitions, breakage of windows, falling of ceilings and light fixtures, and inoperative elevators, air conditioning equipment, and emergency power supplies.

Four major hospitals were severely damaged and evacuated. One was a pre-1933 structure, but three were built since 1960 in accordance with modern codes.

*See *The San Fernando Earthquake of February 9,1971 and Public Policy*, Report by the Special Subcommittee of the Joint Committee on Seismic Safety, California Legislature, July 1972.

As demonstrated in every destructive earthquake in California since passage of the Field Act in 1933, schools built according to the provisions of that act fared well in contrast to schools built before 1933 and not modified to meet the earthquake provisions of the act.

Liquefaction caused a landslide on a 2 degree slope, affecting the city's Juvenile Hall. Disruption of the foundations of this facility led to the collapse of a part of the structure and extreme damage elsewhere.

**Damage to Dams.** The Upper and Lower Van Norman dams were in the area of strong shaking and were damaged. Both are earth fill dams and were constructed using hydraulic fill procedures. During the earthquake a portion of the embankment, including the crest, of Upper Van Norman Dam slipped downstream about five feet and the crest settled three feet.

The upstream portion of the embankment of Lower Van Norman Dam, including the dam crest and a portion of the upstream slope, for a length of 1,800 feet, slid into the reservoir reducing the height of the dam by 30 feet. If the reservoir's level had not been 35 feet below the crest, water would have been released with likely loss of the dam and inundation of an area inhabited by 80,000 people.

**Damage to Utilities.** Within the area of strong shaking, utilities were severely damaged. Underground water, sewer, and gas pipes were severely damaged in areas of ground failure, particularly along the San Fernando fault.

Liquefaction of sand in the foundation materials at the Jensen Filtration Plant caused lateral movement, much ground cracking, and damage to the plant estimated at $1 million.

There was serious damage to electrical facilities within a three-mile radius of Sylmar; buildings stood up well but electrical equipment very poorly. The $100 million Sylmar Converter Station was completely disabled.

The most extensive damage to telephone facilities was in the Sylmar and Newhall areas. The central switching station in Sylmar was put out of operation and most of the operating equipment was toppled. Damage to buildings, however, was light.

There was $15 million in damage to the freeway system in the area of strong ground shaking. Forty-two bridge structures were damaged; five collapsed due to vibration failures. Numerous embankment and abutment failures also occurred.

To study and evaluate the effects of the San Fernando earthquake in terms of public policy needs, the special subcommittee was assisted by a number of consultants well qualified in their respective fields*. Their findings and conclusions have served as a basis for many of the recommendations made in the present report.

* See the Special Subcommittee Report, op cit., p. viii.

# APPENDIX E: POTENTIAL EARTHQUAKE LOSSES IN THE SAN FRANCISCO BAY AREA

In 1972 the National Oceanic and Atmospheric Administration (NOAA) ised a report on a study made to provide a rational basis for planning rthquake disaster relief and recovery operations in the San Francisco Bay A:a*. The NOAA study reviewed the probable effects of three different-sized rthquakes (Richter magnitudes 6.0, 7.0, and 8.3) occurring on either the San Adreas or the Hayward fault, at three different times of day (2:30 a.m., 2:00 p.., and 4:30 p.m.), and in either the wet or the dry season.

The study examined the effects of the earthquakes on local medical rources; that is, the performance of hospital buildings and consequent pbable loss of available bed space, as well as the probable loss of manpower a l medical supplies. The quality of the structures housing the 7 blood banks a l 82 ambulance services in the area, and the packaged disaster hospitals (derally-owned emergency supplies) were also examined to determine the a ilability of these services after the assumed earthquakes.

It is interesting to note that, for comparable earthquakes, the Hayward fault vuld create a much more hazardous situation than the San Andreas fault. Iere are eight East Bay hospitals located on or immediately adjacent to the Hyward fault.

The NOAA report goes on to discuss the probable demands on medical r ources, while examining the potential sources of casualties. The latter fall into a umber of broad categories including the collapse of buildings, falling parapets, zards in homes and smaller buildings, and the collapse of freeway overpasses a d bridges. The importance of each of these categories as a source of casualties vries dramatically with the time of day of the event. The greatest number of sualties would occur at 4:30 p.m. in San Francisco due to the fact that a larger pportion of the population would be concentrated in the vicinity of and posed to the greatest hazards.

Finally, the study examined the effects of the earthquakes on vital public eds, including public structures that may be needed after a disaster, mmunications networks, utilities, transportation, emergency housing, and sential supplies distributed through the various kinds of commercial structures.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, *A Study of Earthquake Losses in the San Francisco Bay Area,* a report prepared for the U.S. Office of Emergency Preparedness, 1972.

## APPENDIX F: SCR 128 (1969)

### Senate Concurrent Resolution No. 128

### RESOLUTION CHAPTER 378

*Senate Concurrent Resolution No. 128—Relating to a Joint Committee on Seismic Safety.*

[Filed with Secretary of State August 25, 1969.]

WHEREAS, The State of California has a positive interest in minimizing the disastrous effects of major earthquakes particularly in the heavily populated areas of the state such as the San Francisco Bay and the Los Angeles metropolitan areas; and

WHEREAS, An earthquake of the magnitude of the 1906 San Francisco catastrophe should it occur today could result in untold loss of life and inestimable property damage due to the rapid growth of urban areas in the past 60 years; and

WHEREAS, The Legislature finds that a considerable reduction in catastrophic damage due to earthquake could possibly be achieved if a detailed study is undertaken to determine the nature of California seismic and related hazards, the effect of seismic rupture upon existing metropolitan structures, utility services, transportation, communications, and the general welfare, and in what manner precautions can be taken to minimize the damage, loss of life, and disruption to the economy should a major earthquake occur; and

WHEREAS, The San Francisco Bay area is a most logical place for such a study to begin since the area contains almost all the types of earthquake-related hazards and hazard-increasing circumstances to be found in the state: It is traversed by two major active faults; it has filled land and water-saturated subsoils; its topography includes inhabited hillsides and slopes susceptible to slides; it has many water storage dams and reservoirs; it is heavily populated with attendant urban problems; it has both old and new structures of widely varying design; and it is a nine-county area large enough to permit a thorough and comprehensive study, the findings of which will be of practical value throughout the state; now, therefore, be it

*Resolved by the Senate of the State of California, the Assembly thereof concurring,* As follows:

1. The Joint Committee on Seismic Safety is created and authorized to study with particularity the earthquake related problems confronting the San Francisco Bay area and so much other of the state as it should appear advisable; the committee is further directed to develop seismic safety plans and policies and recommend to the Legislature any needed legislation to

minimize the catastrophic effects upon the people, property, and the operation of our economy should a major earthquake strike any portion of the State of California.

2. The Joint Committee on Seismic Safety shall consist of four members of the Senate appointed by the Committee on Rules which shall also appoint the chairman, plus four members of the Assembly appointed by the Speaker of the Assembly who shall also appoint the vice chairman.

3. The Joint Committee shall be advised by the advisory groups set forth below:

A. Advisory Group on Engineering Considerations and Earthquake Sciences.

This group shall review available scientific and engineering knowledge relative to the reduction of the risks of damage due to earthquake and related geologic hazards. It shall make recommendations to the committee based upon its findings. Its judgment in the fields of engineering and earthquake sciences shall guide all other advisory groups. It shall review the progress reports of all other advisory groups and may recommend such changes, elaborations, or new directions as may appear desirable. It shall provide, insofar as feasible, technical information and opinions on submitted questions to other advisory groups.

The composition of the Advisory Group on Engineering Considerations and Earthquake Sciences shall include:

(a) One representative of the Division of Mines and Geology appointed by the Secretary of the Resources Agency.

(b) One representative of the Division of Safety of Dams appointed by the Secretary of the Resources Agency.

(c) One representative of the Office of Architecture and Construction appointed by the State Architect.

(d) Seven persons with experience and acknowledged reputations in the relevant professional fields shall be appointed by the committee as follows:

(i) One representative after consultation with the officers of the San Francisco Section of the American Society of Civil Engineers.

(ii) One representative after consultation with the officers of the Structural Engineers Association of Northern California.

(iii) One representative after consultation with the officers of the San Francisco Chapter, Association of Engineering Geologists.

(iv) One representative after consultation with the officers of the California Council of the American Institute of Architects.

(v) Three representatives after consultation with the officers of the Earthquake Engineering Research Institute.

(e) Two persons representing appropriate academic disciplines appointed by the committee after consultation with the Chancellor of the University of California, Berkeley, and the President of Stanford University.

(f) Two members appointed from the public at large at the discretion of the committee.

B. Advisory Group on Disaster Preparedness.

This group shall be responsible for reviewing and evaluating the adequacy of existing disaster plans insofar as they relate to the probable consequences of disastrous earthquakes. The group should give special emphasis to the development of plans to marshal human, physical, and economic resources necessary to minimize human and material losses flowing from earthquake disaster, and to facilitate restoration of the normal life of the region as expeditiously as possible. The group should recommend preearthquake measures that will help to minimize human and material losses flowing from earthquake disaster.

The composition of the Advisory Group on Disaster Preparedness shall include:

(a) One representative of the U.S. Office of Emergency Preparedness appointed by the Director of the Office of Emergency Preparedness.

(b) One representative appointed by the Director of the Disaster Office of the Governor's Council.

(c) Seven persons appointed by the committee with knowledge in fields relevant to disaster preparedness, including not less than one physician, one representative of a public utility, one civil engineer, one architect, and one representative of the American Red Cross.

(d) Five representatives of local government, appointed by the committee after consultation with the Association of Bay Area Governments. Two of these representatives shall be building inspectors of cities within the San Francisco Bay area and each building inspector shall hold a valid California civil engineer's license.

(e) Three members appointed from the public at large or from private organizations at the discretion of the committee.

C. Advisory Group on Postearthquake Recovery and Redevelopment.

This group shall be responsible for recommending a series of general contingency plans to guide the long-term work of recovery, reconstruction, relocation where desirable, and redevelopment. The plans shall include variable courses of action based upon the several parameters of earthquake location, duration, intensity and damage.

The composition of the Advisory Group on Postearthquake Recovery and Redevelopment shall include:

(a) Four persons appointed by the committee from the fields of insurance, banking and finance, law, and urban renewal.

(b) Four persons with experience and acknowledged reputations in relevant professional fields appointed by the committee as follows:

(i) One representative after consultation with the officers of the California Chapter of the American Institute of Planners.

(ii) One representative after consultation with the officers of the California Council of the American Institute of Architects.

(iii) One representative after consultation with the officers of the San Francisco Section of the American Society of Civil Engineers.

(c) One representative of residents living in areas having substantial proportions of older, low-income housing after consultation with representatives of low-income groups in San Francisco, Oakland, and San Jose.

(d) Three representatives of local government after consultation with the Association of Bay Area Governments.

(e) One representative of the Department of Housing and Community Development appointed by the director.

(f) Two representatives of the public at large appointed at the discretion of the committee.

D. Advisory Group on Land Use Planning.

This group shall determine the limitations that should be placed upon the use of land subject to seismic hazard for appropriate inclusion in the land use plans of state, regional, and local governments.

The composition of the Advisory Group on Land Use Planning shall include:

(a) Three representatives of local government, appointed by the committee after consultation with the Association of Bay Area Governments.

(b) Five persons with experience and acknowledged reputations in relevant professional fields appointed by the committee as follows:

(i) Two representatives after consultation with the officers of the California Chapter of the American Institute of Planners.

(ii) One representative of the San Francisco Section of the American Society of Civil Engineers.

(iii) One representative of the California Council of the American Institute of Architects.

(iv) One representative of the San Francisco Chapter of the Association of Engineering Geologists.

(c) One representative of the State Office of Planning appointed by the State Planning Officer.

(d) Two representatives of the academic community appointed by the commission after consultation with the Chancellor of the University of California, Berkeley, and the President of Stanford University.

(e) Two representatives of the public at large appointed at the discretion of the committee.

E. Advisory Group on Governmental Organization and Performance.

This group shall study local government organization so as to determine how the plans formulated by the other advisory groups to reduce the risk of loss due to earthquake disaster may best be carried into effect. It shall recommend modifications in existing government organization so that local government jurisdiction is sufficient to enable it to exercise the requisite authority to make the emergency measures effective. It shall recommend new governmental institutions should they appear essential.

The composition of the Advisory Group on Governmental Organization and Performance shall include:

(a) Two representatives of local government appointed by the committee after consultation with the Association of Bay Area Governments.

(b) Two persons appointed by the committee after consultation with the chairman of the Joint Committee on Bay Area Regional Organization.

(c) One person appointed by the committee after consultation with the chairman of the Bay Conservation and Development Commission.

(d) Three persons appointed by the committee who have been active in governmental studies in the San Francisco Bay area.

(e) Three representatives of the public appointed by the committee.

(f) Two representatives of the academic community appointed by the committee after consultation with the Chancellor of the University of California, Berkeley, and the President of Stanford University.

(g) Two representatives from the public at large appointed at the discretion of the committee.

4. The Joint Committee on Seismic Safety and its members shall have and exercise all of the rights, duties and powers conferred upon investigating committees and their members by the provisions of the Joint Rules of the Senate and the Assembly as they are adopted and amended from time to time, which provisions are incorporated herein and made applicable to this committee and its members.

5. The Joint Committee shall have the following additional powers:

(a) To meet at such times and places as it may deem proper.

(b) To employ such professional, secretarial and clerical staff, together with such special assistants and consultants as may be necessary.

(c) To contract with such other agencies, public or private, as it deems necessary, for the rendition of such services, facilities, studies and reports to the joint committee as will best assist it to carry out its duties and responsibilities.

(d) To cooperate with and to secure the cooperation of county, city, city and county, regional, multicounty and other local agencies in investigating any matter within the scope of its duties and responsibilities.

(e) To cooperate with any federal, state or local agency, public and private, which is engaged in making studies of earthquake hazard.

(f) To accept funds from federal, state, and local agencies, and to receive contributions from private sources.

(g) To create additional advisory groups and to do any and all other things necessary or convenient to enable it fully and adequately to perform its duties and to exercise the powers expressly granted it.

6. The Joint Committee on Seismic Safety shall file a progress report with the Legislature not later than June 30, 1970, and shall file a final report with the Legislature not later than June 30, 1974. The final report shall contain:

(a) The results of the detailed study made by the committee.

(b) A plan for continuous revision of the study as new information is obtained.

(c) A plan to minimize the probable loss to life, property, and minimize the disruption of the local economy should an earthquake disaster occur.

(d) A plan for appropriate and effective response to the immediate problems arising after an earthquake disaster.

(e) Such other information and recommendations as the committee deems desirable.

7. The sum of five thousand dollars ($5,000) or so much thereof as may be necessary is hereby made available from the Contingent Funds of the Assembly and Senate for the expenses of the committee and its members and for any charges, expenses or claims it may incur under this resolution, to be paid from the said fund and disbursed, after certification by the chairman of the committee, upon warrants drawn by the State Controller upon the State Treasurer.

THIS BOOK IS DUE ON THE LAST DATE
STAMPED BELOW

BOOKS REQUESTED BY ANOTHER BORROWER
ARE SUBJECT TO IMMEDIATE RECALL

NOV 8 1990

RECEIVED
AUG 26 1991
PHYS SCI LIBRARY

LIBRARY, UNIVERSITY OF CALIFORNIA, DAVIS

Book Slip–Series 458

1061470

QE
89
A1
C32
no.45

PHYSICAL
SCIENCES
LIBRARY

California. Legislature. Joint Committee on Seismic Safety.

Meeting the earthquake challenge; final report to the Legislature, State of California. [Sacramento, 1974.

viii, 223 p. illus. 23 cm.

1. Earthquakes and building—Safety regulations—California. 2. Earthquakes—California. 3. Disaster relief—California. I. Title.

KFC813.A2 1974 346.794045 74-621461
MARC

hem 3/75

Library of Congress

Zebra on
next page